Trade Shocks in Distorted Economies:

Evidence from Firm-level Import Data from 57 Countries*

Rodrigo Adão
University of Chicago

Ana Fernandes
World Bank

Chang-Tai Hsieh
University of Chicago

Jose M. Quintero
University of Chicago

March 21, 2025

Abstract

We construct a dataset of firm-level imports for 57 countries to measure importer firm concentration and its impact on the aggregate and distributional effects of tariff changes. Our model links importer concentration to the domestic market power of importer firms, as summarized by the firm-level elasticity of imports to tariff changes. In our data, this elasticity decreases monotonically with a firm's import share of a given good, implying that the firm's markup increases with its import share. Given these estimates, the incidence of tariff changes depends on between- and within-good heterogeneity in (i) import responses and (ii) initial markups. Among the trade liberalization episodes in our sample, we find that import market concentration induces changes in allocative efficiency comparable in magnitude to welfare changes predicted by neoclassical mechanisms. The higher and more dispersed concentration in import markets of poorer and smaller countries amplifies welfare effects through changes in allocative efficiency.

*We thank Monica Morlacco and Ken Kikkawa for helpful comments. We are grateful to Seha Karabacak and Paula Londoño for superb research assistance. This paper has been partly supported by the Umbrella Facility for Trade trust fund (financed by the governments of the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom). The findings, interpretations, and conclusions expressed in this paper are solely those of the authors and do not necessarily represent the views of the World Bank, its affiliated organizations, or the Executive Directors and the countries they represent.

1 Introduction

This paper constructs a new dataset of harmonized firm-level import customs records for 57 countries from 1997 to 2021. We combine this dataset with information on bilateral product-specific tariffs across those countries to construct firm-level tariff changes over time. Using these data we measure importer firm concentration across countries and study its impact on the incidence of tariff changes through the domestic market power of importer firms.

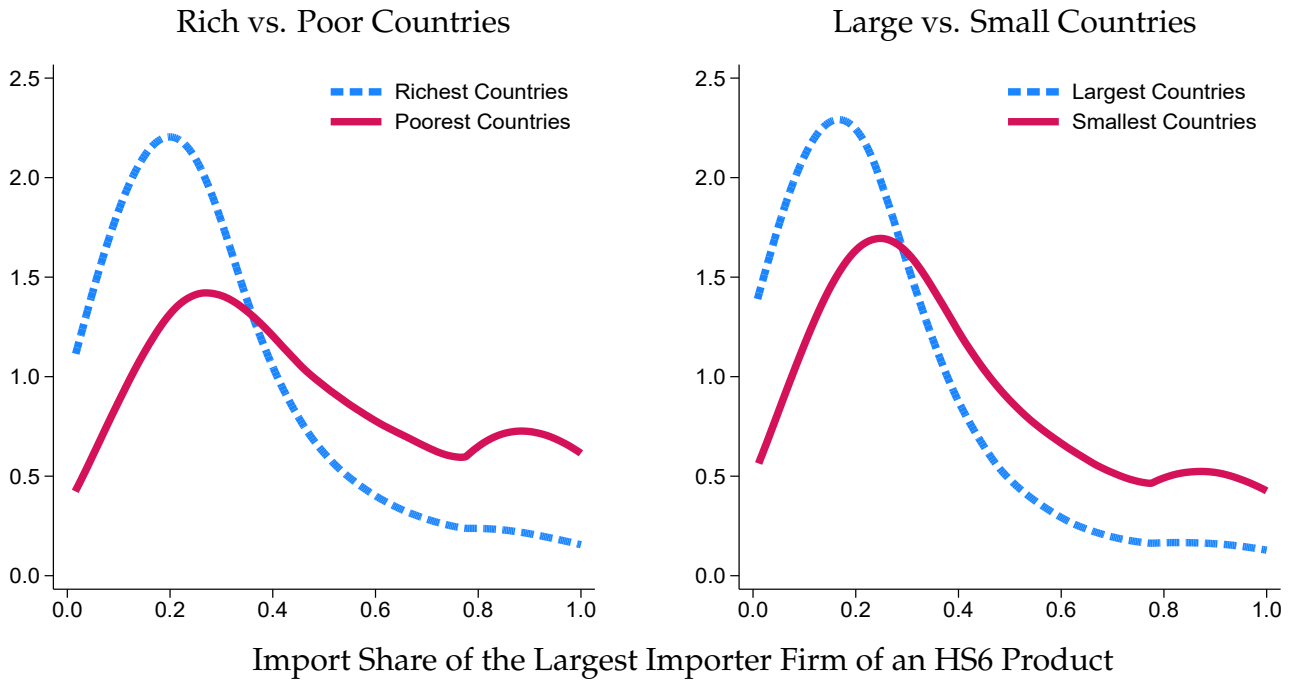
We highlight two facts. First, trade liberalization episodes not only reduce a country's average tariffs but also generate dispersion in tariff cost changes across goods and firms. For the countries in our sample, the correlation between the average tariff change and the between-good dispersion in tariff changes is -0.63. Trade liberalization episodes also have heterogeneous effects on the tariff costs of firms importing the same good from different origins: in our sample, the correlation between a country's average tariff change and the within-good dispersion of changes in firm-specific average tariff costs is -0.51.

When the marginal product is the same between importer firms, the heterogeneous effect of tariff reductions would have no aggregate impact beyond the effect of the average tariff change. However, our second fact is that markups are likely to differ between importer firms. Figure 1 displays the distribution of the import share of the largest importer firm of each product for the five richest and poorest countries (left panel) and the five largest and smallest countries (right panel) in our sample. The figure shows the significant dispersion in the import share of the largest importer firm. It also shows that both the level and the dispersion of importer firm concentration are higher in poorer and smaller countries.

Motivated by these two facts, we propose a model that allows the domestic pricing decisions of importer firms to depend on their share of the country's imports of a good. In our model, each importer firm's perceived elasticity of domestic demand is a function of its share of the domestic market of the imported good, similar to Atkeson and Burstein (2008) and Amiti et al. (2019a). An increase in tariffs that raises costs of larger importers of a good relative to other importers of the same good causes larger importers to reduce more their domestic markups and, consequently, to reduce less their import spending. This relationship maps directly to how much the firm's perceived elasticity of domestic demand varies with its market share, which, in turn, determines the importer firm's domestic markup and its sensitivity to tariff changes.

Building on this insight, we highlight two determinants of the aggregate and distributional effects of tariff changes. First, they depend on the heterogeneous impact of tariff

Figure 1: Distribution of the Import Share of the Largest Importer Firm in an HS6 Product



Notes: Figure shows distribution of the import share of the largest importer firm in each product-country-year for the five richest and poorest countries (left panel) and the five largest and smallest countries (right panel) in our sample of 57 countries. Product definition is the 6-digit Harmonized Schedule (HS6). Poorest countries are Burundi, Guinea-Bissau, Madagascar, Malawi, and Rwanda; Richest countries are Chile, Croatia, Mexico, Romania, and Uruguay. Smallest countries are Comoros, Cape Verde, Sao Tome and Principe, Montenegro, and Mauritius; Largest countries are Bangladesh, India, Mexico, Indonesia, and Pakistan. Mean (standard deviation) of the import share of largest importer firm are 0.30 (0.22) for richest, 0.49 (0.29) for poorest, 0.25 (0.22) for largest, and 0.42 (0.28) for smallest countries. Kernel density estimates use a bandwidth of 0.1. Observations weighted by share of HS6 product in each country's imports.

changes between and within goods. Between goods, tariff changes that lower the relative cost of imported goods with higher firm concentration trigger resource reallocation towards those goods. In our framework, since average markups are higher in more concentrated goods, this improves allocative efficiency while increasing the country's average markup. Within goods, tariff changes that lower the relative cost of larger importers of a good causes resources to reallocate towards larger importers. In our model, since larger firms have higher markups, this improves allocative efficiency and raises the good's average markup. For these results, it is key that import cost shocks have heterogeneous effects between and within goods. When trade shocks hit all goods and firms equally, there is no resource reallocation nor markup changes among importer firms.

Second, the effect of an import cost shock also depends on the country's import market structure. The shock's aggregate effect depends on the difference in markups between goods and between importers of the same good. In our model, the gap in average

markups across products increases with the gap in market concentration across products. Likewise, for any given imported good, the dispersion in domestic markups between firms increases with the dispersion in import shares between firms. The more dispersed the markups, the stronger the allocative efficiency effects arising from tariff-induced reallocation between and within goods.

Armed with these theoretical insights, we turn to the measurement of import market structure in our sample of countries. In line with Figure 1, on average across goods, the Herfindahl–Hirschman Index (HHI) of firm import shares is high, and even higher in smaller and poorer countries. In addition, both between- and within-good dispersion in import firm concentration are negatively related with the country's size and income. Through the lens of our model, these findings suggest that, due to changes in allocative efficiency, trade shocks have the potential to generate larger aggregate and distributional effects in poorer and smaller countries.

We then use our model to go from the country's distribution of firm import shares across goods to its joint distribution of markup levels and import elasticities across firms and goods, which determines the incidence of tariff changes in our model. The key moment linking these two distributions is the elasticity of the firm's imports to its average tariff cost, and how this elasticity varies with the firm's import share of a good. Our model yields an empirical specification for firm-level imports that accounts for strategic complementarities in pricing decisions within a market by including good-country fixed effects interacted with a flexible function of the firm's import share.

We find evidence that concentration in import markets affects firm pricing decisions. The magnitude of the firm-level elasticity of imports to average tariff cost decreases monotonically with the firm's import share. For firms with low import shares, an increase of 1 log-point in tariff costs induces a decline in their imports of 2.5 log-points. In contrast, the same shock induces only a reduction of 1 log-point in the firm's imports of a good for which it accounts for more than 50% of the country's imports. These estimates imply that domestic markups range from 1.6 for small importers to 2.5 for larger ones, with an elasticity to tariff costs near zero for small importers and -0.6 for larger importers. When we aggregate these responses across all importers of a good, we find that a tariff-induced increase of 1 log-point in the average price of a good causes a reduction in its domestic expenditure of 1.8 log-points.

We conclude by using our firm-level estimates of markup levels and import elasticities to quantify the contribution of import firm concentration for the incidence of tariff changes in our sample of countries and years. For aggregate welfare, domestic market power of importer firms generates changes in allocative efficiency whose magnitude is

similar to the contribution of neoclassical channels associated with tariff distortions. Because importer firm concentration is higher and more dispersed in poorer and larger countries, they also exhibit a larger contribution of changes in allocative efficiency for tariff incidence.

Take, for example, the effect of trade liberalization in the Dominican Republic vs. Romania. Average tariffs fell by roughly the same amount in the Dominican Republic when it entered the US-CAFTA-DRA (in 2006) as in Romania when the latter joined the EU (in 2007). Furthermore, in both trade liberalization episodes, tariffs fell by more for some products and firms compared to others. However, consistent with the pattern shown in Figure 1, the dispersion of import market concentration was higher in the Dominican Republic (the poorer country) compared to Romania (a richer country). As a consequence, our model suggests that an otherwise comparable trade liberalization generated larger gains in allocative efficiency in the Dominican Republic compared to Romania.[1]

Our paper builds on the large literature studying the aggregate effect of distortions. Atkin and Donaldson (2022) present suggestive evidence that distortions are likely to be more prevalent in low-income countries and to matter for the welfare effect of trade openness. We focus on a single source of distortions, domestic market power created by importer firm concentration, and measure the effect of trade shocks when import markets are concentrated. Our mechanism generates heterogeneity in the levels and responses to tariff changes of markups across firms depending on their market share, as in Edmond et al. (2015) and Amiti et al. (2019a). In this setting, we build on the insights in Baqaee and Farhi (2020; 2024), Atkin and Donaldson (2022), and Adão et al. (2023) to show that importer firm concentration matters for tariff incidence only through the covariance between tariff-induced changes in imports and initial relative markups across both imported goods (between-good reallocation) and firms importing the same good (within-good reallocation).

To measure the sufficient statistics in our tariff incidence formulas, we use a panel dataset of firm-level imports in 57 developing countries. It allows us to estimate how the firm's elasticity of imports to average tariff costs varies with its share of the country's imports. This is closely related to the evidence in Amiti et al. (2019a) of imperfect pass-through from foreign price shocks to domestic prices, as well as pass-through heterogeneity with respect to firm size. Our contribution is to explicitly link heterogeneity

[1] As we show later, we calculate that the entry of the Dominican Republic into US-CAFTA-DRA in 2006 generated welfare gains equivalent to 6.6% of initial imports, with a contribution of 4.7% arising from an improvement in allocative efficiency. Romania's EU accession in 2007 created smaller allocative gains through importer firm concentration equivalent to 0.4% of its initial imports, with a total welfare gain of 1.8% of initial imports.

in import responses to the heterogeneity in markups within and between goods, which we then use to show that distortions generated by importer firm concentration are an important determinant of tariff incidence, with an even greater importance for smaller and poorer countries.

More generally, we build upon the theoretical and empirical frameworks used to study how shock transmission across countries depends on the strategic pricing decision of *exporter* firms. In particular, Atkeson and Burstein (2008), Berman et al. (2012), and Amiti et al. (2014) measure how pricing decisions of exporting firms depend on their share of export markets – see Burstein and Gopinath (2013) for a review of this literature.[2] Our focus is not on exporter firms but on the strategic pricing decision of importer firms and its implications for how importer firm concentration shapes the impact of trade cost changes on the domestic market.

Our analysis uses administrative custom records to recover how domestic markups on imported goods vary with the firm's import share in 57 countries. Our paper thus complements the literature that uses the insight of Hall (1986) to estimate the markup distribution across firms using detailed plant-level data on inputs, output, and prices. Some examples are De Loecker and Warzynski (2012) and De Loecker et al. (2016).[3] At the cost of relying on stronger assumptions on technology, demand and market structure, our procedure only requires custom records that we harmonize for a large set of countries. The payoff are estimates of the component of markups associated with the firm's market share among *all* importer firms in 57 countries. Our estimates suggest that distortions associated with markup *dispersion* on imported goods are larger in poorer and smaller countries.[4]

This paper focuses on markups of importer firms, and is silent on markups of domestic substitutes of imported products and on markups charged by foreign producers. Going back to Krugman (1979), an extensive literature studies the pro-competitive effect of imports on the markups of domestic substitutes of imported products. Edmond et al. (2015) and Arkolakis et al. (2019) also focus on how markups of foreign producers respond to trade costs. We assume that prices of foreign producers are exogenous to the importing countries in our sample. We find that, consistent with this assumption, prices of foreign products do not change with trade costs in our dataset, in line with recent evidence in

[2] Amiti et al. (2014) focus on exporter firms that are also importers and measure the pass-through of changes in exchange rates for such firms.

[3] See De Loecker and Goldberg (2014) for a review.

[4] The welfare cost from dispersion in marginal product (some of which are likely due to markup dispersion) is the subject of a large literature, starting with Hsieh and Klenow (2009). We are not aware of cross-country estimates of the dispersion in markups using comparable data from a large number of countries.

Fajgelbaum et al. (2019) and Amiti et al. (2019b).[5]

Our paper is organized as follows. Section 2 presents our model linking importer firm concentration to the pricing decisions of importer firms and its implications for the incidence of tariff changes. Section 3 documents patterns of importer firm concentration across countries. Section 4 provides estimates of how the firm-level elasticity of imports to tariffs varies with the firm's import share of a good. In Section 5, we quantify the role of importer firm concentration for tariff incidence in our sample of countries. Section 6 concludes.

2 A Model of Oligopolistic Importer Firms

This section presents our model that links import firm concentration to the strategic pricing decisions of importer firms in the domestic market. We show that import firm concentration shapes the aggregate and distributional effects of tariff changes through the covariance across importer firms of their initial domestic markups and import responses. To measure this covariance in our model, we require data on firm-level customs records and estimates of the elasticity of the firm's imports to its average tariff cost (as a function of the firm's share of the country's imports of a good).

To simplify exposition, we derive our main insights in the context of a small open economy with a simple structure of preferences and production. We then consider generalizations for richer environments.

2.1 Environment

We consider a small open economy populated by workers who supply $\bar{L}^D$ units of domestic labor and owners who operate an exogenous set of firms, where firm f produces a variety of good g. We classify goods into three groups: (i) goods sold in the domestic market produced using only labor of domestic workers; (ii) goods sold in the domestic market produced using only foreign inputs; and (iii) goods sold in export markets produced using only the owner's firm-specific labor endowment (denoted by $\bar{L}^X_{gf}$).

[5]We also abstract from other mechanisms via which importer firms may matter for tariff incidence. For example, Alviarez et al. (2023) focus on bilateral bargaining between exporters and importers, and Blaum et al. (2018, 2019) show how importer firms affect domestic prices through their input sourcing choices.

Preferences. Workers and owners have identical homothetic preferences given by

$$C = \left[\sum_g (C_g)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \quad \text{with} \quad C_g = \left[\sum_f (q_{gf})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}},$$

where q_{gf} denotes the consumption of the variety of good g supplied by firm f, and σ and η denote respectively the elasticity of substitution across firms and goods. We assume that domestic and imported varieties are bundled in different nests as we observe only firm-level imports. This nesting structure enables us to estimate the model while accommodating a flexible substitution pattern between firms and goods.[6]

Given prices p_{gf}, domestic demand for the variety of good g supplied by firm f is

$$q_{gf} = (p_{gf})^{-\sigma}(P_g)^{\sigma-\eta}Q \quad \text{with} \quad (P_g)^{1-\sigma} = \sum_f (p_{gf})^{1-\sigma},$$

such that Q is a demand shifter given by

$$Q = P^{\eta-1}E \quad \text{and} \quad P^{1-\eta} = \sum_g (P_g)^{1-\eta},$$

with E denoting aggregate expenditure and g an imported or domestic good.

Technology. For importer firms supplying a variety of good g, production combines foreign varieties of the good from different origins o:

$$Y_{gf} = \left[\sum_o (a_{ogf})^{\frac{1}{\theta}}(q_{ogf})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}},$$

where q_{ofg} are imports by firm f of foreign good g from origin o, $a_{ogf} \geq 0$ is an origin-firm productivity shifter, and $\theta > 1$ is the elasticity of substitution across foreign origins.

The production function of domestic and exporter firms is linear in labor: $Y_{gf} = a_{gf}L^h_{gf}$, where a_{gf} is an exogenous productivity shifter, and L^h_{gf} is the specific type of labor used by the firm, $h \in \{D, X\}$.

Our choice of the production technology greatly simplifies exposition, since it entails

[6]Due to data availability, Fajgelbaum et al. (2020) and Adão et al. (2023) impose similar nesting structures of preferences. To simplify exposition, we also impose that all goods belong to a single sector and that the elasticity of substitution between domestic and imported goods within a sector is the same. Although our nested CES demand simplifies exposition, we later allow for generic homothetic preferences between goods in the upper nest and homothetic single aggregator preferences across firms in the lower nest.

segmented factor markets for the three types of goods. This implies that changes in import costs do not affect the cost of producing domestic or exported goods.[7]

Foreign Offer Curve. Importers face an identical and exogenous world price p_{og}^W and exporters face a perfectly elastic world demand curve at price p_g^W.[8]

Government. The government imposes an ad-valorem import tax of τ_{og} on good g from origin o. This implies that the cost of foreign goods for importer firms is $p_{og} = (1 + \tau_{og})p_{og}^W$. The tariff revenue is rebated to workers and owners with a lump-sum transfer:

$$T = \sum_g \sum_f \sum_o \tau_{og} p_{og}^W q_{ogf}.$$

Market Structure. Each firm acknowledges the impact of its pricing decision on its domestic demand while taking as given prices of other firms and the aggregate demand shifter Q, as in Atkeson and Burstein (2008) and Amiti et al. (2019a). Our nested structure of demand implies that pricing decisions of firms in other nests only affect a firm's demand through the common shifter Q. This is the key assumption that allows us to link firm-level import data to the distribution of domestic prices set by importer firms, without data on sales by domestic firms.

The elasticity of substitution between goods, η, summarizes the domestic competition of other goods. It determines how the pricing decision of an importer depends on its size (relative to other importers of the same good). We assume $1 < \eta \leq \sigma \leq \eta^2$, which guarantees that firms have finite markups that increase with their revenue, employment, and imports.

We further assume that firms are price takers in the world good market and in the domestic labor market. That is, each firm takes as given the world prices of both imported and exported goods, as well as the wages of domestic workers.

Market Clearing. Labor supply must be equal to labor demand. For every exporter firm, this requires $L_{gf}^X = \bar{L}_{gf}^X$. For domestic firms, this implies $\bar{L}^D = \sum_g \sum_f L_{gf}^D$.

[7] We show below that our key insights remain the same if we allow production of all goods to use the same type of domestic labor. We also allow firms to use intermediate goods, provided that production follows a nesting structure identical to that of final demand–a common restriction in quantitative trade models (Costinot and Rodríguez-Clare, 2014).

[8] We consider below an extension with endogenous world prices of exported and imported goods.

For goods market to clear, aggregate domestic spending must be equal to the income from labor, profits and tariff revenue:

$$E = w\bar{L}^D + \sum_g \sum_f \Pi_{gf} + T.$$

where w is the wage rate and Π_{gf} is the profit earned by the owner of firm f supplying variety of good g (exported, imported, or domestic).[9]

Equilibrium. Conditional on world prices and import tariffs, Appendix A.1 outlines the economy's equilibrium, in which (i) consumers maximize utility given their budget constraint, (ii) firms maximize profits given their technology and perceived demand, (iii) the government balances its budget, and (iv) markets for goods and labor clear.

2.2 Firm-Level Markups and Sales in Equilibrium

We now describe how markups and imports vary across firms in equilibrium.[10] For importer firms,

$$p_{gf} = \mu_{gf} c_{gf} \quad \text{such that} \quad \mu_{gf} = \frac{\varepsilon_{gf}}{\varepsilon_{gf} - 1} \quad \text{and} \quad \varepsilon_{gf} = \sigma - (\sigma - \eta) e_{gf},$$

where c_{gf} denotes the marginal cost of firm f and $e_{gf} \equiv p_{gf} q_{gf} / P_g C_g$ its share of domestic expenditure on good g.

For each producer f of good g, the optimal price entails a markup over marginal cost of μ_{gf}, which is decreasing in the firm's perceived elasticity of domestic demand with respect to its own price, ε_{gf}. Our model's oligopolistic market structure implies that the perceived elasticity of domestic demand is endogenous. As a consequence of the nesting structure of preferences, it only depends on the price of other producers of the same good g through the firm's share of domestic expenditure on that good, e_{gf}.

In equilibrium, producers of good g differ in their markups μ_{gf} and imports q_{gf}.[11] Formally, holding constant good-level variables,

$$\beta^{\mu}_{gf} \equiv -\frac{\partial \log \mu_{gf}}{\partial \log c_{gf}} = \frac{\rho_{gf}}{1 + \rho_{gf}} \quad \text{and} \quad \beta^{q}_{gf} \equiv -\frac{\partial \log q_{gf}}{\partial \log c_{gf}} = \frac{\sigma}{1 + \rho_{gf}}$$

[9] Since the consumers' budget constraint requires $E = \sum_g \sum_f p_{gf} q_{gf}$ where g is an imported or a domestic good, the market clearing conditions above imply trade balance.

[10] The derivations are in Appendix A.2.

[11] Among importer firms, since c_{gf} is the import cost index, q_{gf} is also the firm's import quantity index. Thus, in the rest of the paper, we refer to q_{gf} as the firm's imports.

where $\rho_{gf} \equiv (\sigma - \varepsilon_{gf})(\sigma - 1)/\varepsilon_{gf}(\varepsilon_{gf} - 1)$. Note that $\varepsilon_{gf} \in [\eta, \sigma]$ implies that $\rho_{gf} \geq 0$.

Firms with high marginal cost and negligible market share, $e_{gf} \approx 0$, behave as in monopolistic competition by setting a constant markup of $\sigma/(\sigma - 1)$. For firms with lower marginal costs, the perceived elasticity of demand is lower if $\eta < \sigma$. As a result, these firms charge higher markups but have lower prices and higher imports, $\beta^{\mu}_{gf} \in [0, 1)$ and $\beta^{q}_{gf} \in (0, \sigma]$. This stems from the fact that the between-good elasticity, which is lower than the between-firm elasticity, becomes a more important determinant of the perceived demand elasticity as the firm's market share increases. Consequently, the average markup is higher for goods with higher concentration of market share across firms.

Accordingly, firm f's markup is intrinsically related to its import elasticity:

$$\mu_{gf} = \mathcal{M}(\beta^{q}_{gf}),$$

with $\mathcal{M}(.)$ strictly decreasing. Intuitively, the import elasticity, β^{q}_{gf}, summarizes strategic pricing behavior created by both the level and the sensitivity of the firm's perceived demand elasticity. The function $\mathcal{M}(.)$ simply links back the firm's perceived demand elasticity ε_{gf} to its import elasticity β^{q}_{gf}. We leverage the mapping $\mathcal{M}(.)$ to identify the distribution of domestic markups among importer firms, μ_{gf}, from the sensitivity of each firm's imports to its import cost, β^{q}_{gf}, which we can estimate using firm-level customs data (and without firm-level data on domestic prices and sales).

For any given firm, the partial-equilibrium elasticities of import quantity and (tariff-inclusive) import expenditure are intrinsically related, since firm f's import expenditure on good g is $M_{gf} = c_{gf} q_{gf}$ and, thus, $-\frac{\partial \log M_{gf}}{\partial \log c_{gf}} = \beta^{q}_{gf} - 1$. As a result, importers of good g with higher domestic output also have higher import expenditure if, and only if, $\beta^{q}_{gf} > 1$. This holds whenever $\sigma \in (\eta, \eta^2)$, which guarantees that the perceived demand is sufficiently elastic to induce more productive firms to have higher import expenditure. Intuitively, a sufficiently elastic demand limits the extent to which more productive firms want to cut output in order to increase their markups and profits. As we show below, $\beta^{q}_{gf} > 1$ is the empirically relevant case.

2.3 The Impact of Import Cost Changes

We now analyze how the economy responds to exogenous changes in import tariffs.[12]

[12] We consider the first-order approximation of equilibrium outcomes, as derived in Appendix A.3.

2.3.1 Firm-level Responses

Changes in import costs affect firms through their marginal costs. For importer firms, this is the import-weighted average of changes in import costs:

$$d \log c_{gf} = \sum_o m_{ogf} d \log(1 + \tau_{og}), \tag{1}$$

with m_{ogf} the share of origin o in firm f's imports of good g.

In response to the change in import costs, importer firms adjust markups and imports:

$$\begin{aligned} d \log q_{gf} &= -\beta^q_{gf}(d \log c_{gf} - d \log c_g) - \eta d \log c_g + d \log Q \quad (2) \\ d \log \mu_{gf} &= -\beta^\mu_{gf}(d \log c_{gf} - d \log c_g) \quad (3) \end{aligned}$$

where $d \log c_g \equiv \sum_f \omega_{gf} d \log c_{gf}$ is a weighted average of cost changes among importers of g, with $\omega_{gf} \equiv \mu_{gf} m^q_{gf} / \sum_{f'} \mu_{gf'} m^q_{gf'}$ and $m^q_{gf} \equiv M_{gf} \beta^q_{gf} / \sum_{f'} M_{gf'} \beta^q_{gf'}$. The endogenous shifter, $d \log Q$, summarizes the general-equilibrium demand response, which is common to all firms.

Changes in markups and imports depend on the change in the average import cost of firm f relative to all importers of the same good. The firm-specific elasticities β^μ_{gf} and β^q_{gf} summarize strategic considerations in domestic price setting, which depend on the firm's relative size:

$$\beta^q_{gf} = \beta^q(m_{gf}) \quad \text{and} \quad \beta^\mu_{gf} = 1 - \beta^q(m_{gf})/\sigma \tag{4}$$

with $m_{gf} \equiv M_{gf} / \sum_{f'} M_{gf'}$ and

$$\frac{\partial \beta^q(m)}{\partial m} < 0 \quad \text{and} \quad \beta^q(0) = \sigma.$$

Given the same relative change in average import cost, larger importers of good g reduce more their domestic markups and, consequently, less their imports. In the limit, small firms with $m_{gf} \approx 0$ behave as in monopolistic competition: they choose to completely adjust prices (i.e., $\beta^\mu(0) = 0$), which causes imports to decline by σ (i.e., $\beta^q(0) = \sigma$). For larger importers of good g, the sensitivity of import (markup) responses is lower (higher). When $\sigma - \eta$ is larger, the firm's perceived demand elasticity declines more with its relative size among importers of good g and, thus, the slope of $\beta^q(m)$ is steeper.

For all domestic firms, the change in the marginal cost is equal to the change in the domestic wage, $d \log c_{gf} = d \log w$. Due to our model's market structure, the identical marginal cost change for all domestic firms implies that their markups remain unchanged,

$d \log \mu_{gf} = 0$, and that their output change by the same amount, $d \log q_{gf} = d \log q^D$. Since domestic labor is employed exclusively by domestic firms, the labor market clearing condition ensures that the output of domestic firms remain constant, $d \log q^D = 0$. Intuitively, because of the segmentation in domestic demand and factor markets, the economy's resource constraint insulates domestic firms from foreign shocks.[13]

2.3.2 Aggregate and Distributional Welfare Responses

We now turn to responses in the economy's aggregate outcomes. To focus on the implication of importer market power, we consider now the incidence of a tariff increase around an initial equilibrium without tariffs; that is, $T_{ogf} = 0$.

Aggregate Effect. We start with the shock's aggregate welfare effect defined as the sum of the equivalent variation across workers and owners.[14] This corresponds to the change in real aggregate expenditure, which is given by

$$dC = \sum_g \sum_f (p_{gf} - c_{gf}) dq_{gf}. \tag{5}$$

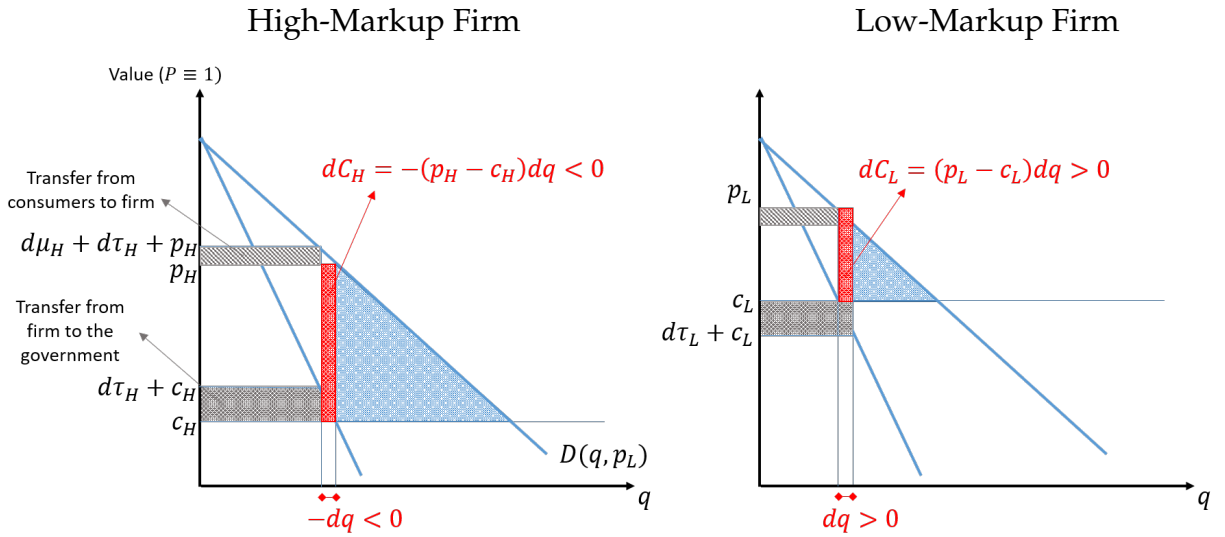
The effect of tariff changes on aggregate welfare corresponds to the change in allocative efficiency due to domestic market power. This arises from the reallocation of resources across firms with distinct levels of market power – e.g., Baqaee and Farhi (2020; 2024), Atkin and Donaldson (2022), and Adão et al. (2023). Expression (5) is the sum of the shock's first-order impact on the Harberger triangles associated with the deadweight losses in the domestic sales of all firms, calculated as the initial markup distortion ($p_{gf} - c_{gf}$) multiplied by the change in production (dq_{gf}). It indicates that welfare gains are larger for shocks that help to correct initial distortions by reallocating production towards goods and firms with inefficiently low supply in the initial equilibrium due to a high markup relative other goods and firms.

Figure 2 illustrates the intuition behind expression (5). It represents the equilibrium of an economy with two firms that import a single good: the high-markup (low-cost) firm on the left panel and the low-markup (high-cost) firm on the right panel. In the initial equilibrium, the economy's deadweight loss is the sum of the Harberger triangles

[13] Our model thus implies that import cost changes do not induce reallocation of resources across domestic and importer firms, which shuts down potential margins of adjustment in the economy. As we discuss below, away from this limiting case, richer structures of demand or technology imply that sales of domestic firms respond to import costs.

[14] This is the measure of aggregate welfare implied by a utilitarian social welfare function.

Figure 2: First-Order Impact of Tariff Changes on Aggregate Welfare



Notes: Figure illustrates impact of tariff changes that induce symmetric changes in dq for the high-markup firm (left panel) and low-markup firm (right panel). The numeraire is the ideal price index, $P \equiv 1$. The blue triangles represent the deadweight loss in the initial equilibrium. The red rectangles represent the first-order change in the deadweight loss of each firm, whose sum is negative due to the contraction of the high-markup firm. The gray rectangles represent the changes in consumer welfare (diagonal lines) and government revenue (dotted area).

in blue. We now consider a tariff change that induces sales of the high-markup (low-markup) firm to contract (expand) by dq. The first-order impact of the policy on welfare is denoted by the two red rectangles whose areas are given by the product of the initial markup and the change in production. Because the policy reallocated consumption from the high-markup to the low-markup firm, aggregate welfare falls as the deadweight loss increase for the high-markup firm is larger than the decrease for the low-markup firm.

Note that neither changes in tariffs nor markups themselves have a direct impact on aggregate welfare. Conditional on changes in production, tariff and markup adjustments simply represent transfers from firms to the government and consumers, as illustrated by the two gray rectangles in Figure 2.

Using the firm-level responses in Section 2.3.1, we can re-write expression (5) in terms of variables in the initial equilibrium and import cost changes:

$$\frac{dC}{M} = -Cov_g\left[(\bar{\mu}_g - \bar{\mu})\eta, d\log c_g\right] - E_g\left[\frac{\bar{\mu}}{\bar{\mu}_g^q} Cov_{f|g}\left[(\mu_{gf} - \bar{\mu}_g^q)\beta_{gf}^q, d\log c_{gf}\right]\right] \tag{6}$$

such that $Cov_s[.,.]$ and $E_s[.]$ denote the import-weighted covariance and average across goods ($s = g$) or importers of a good ($s = f|g$). The terms $\bar{\mu}_g \equiv E_{f|g}[\mu_{gf}]$ and $\bar{\mu}_g^q \equiv$

$E_{f|g}[\mu_{gf}\beta^q_{gf}]/E_{f|g}[\beta^q_{gf}]$ are import-weighted averages of domestic markups across importers f of good g, and $\bar{\mu} \equiv E_g[\bar{\mu}_g]$ is the import-weighted average of domestic markups across all imported goods.

Expression (6) links allocative efficiency to reallocation along two margins: across imported goods (first term) and across firms importing the same good (second term). Each margin corresponds to an import-weighted covariance that quantifies the extent to which an import cost shock leads to an expansion of imports for more distorted goods and firms, as captured by the product of the initial relative markup and the import elasticity. For the between-firm component in the second term, the aggregate effect is the sum over imported goods of the covariance of the reallocation and distortion across importers of the same good, weighted by the inverse of the good's relative markup.

As a corollary, importer firm concentration only matters for the aggregate incidence of tariffs when the initial level of markups and the change in import costs vary across firms and goods. Figure 2 again illustrates the intuition. If both firms experience the same import cost change, relative prices and imports remain the same.[15] Alternatively, if both firms have the same initial markup, the deadweight loss reduction for one firm exactly compensates the increase for the other firm.

Lastly, expression (6) outlines the sufficient statistics for measuring aggregate tariff incidence. Given any import cost change, measurement requires firm-level custom record, $\{M_{ogf}\}$, as well as estimates of the firm-specific import elasticity function, $\beta^q(m_{gf})$, and the elasticity of substitution across goods, η. This approach leverages the insight that a firm's markup can be inferred from the elasticity of its imports with respect to average import costs, $\mu_{gf} = \mathcal{M}(\beta^q(m_{gf}))$. Importantly, beyond firm-level customs records, no additional data on domestic prices or sales of importer firms is required. Instead, these domestic adjustments are implicitly captured through the extent to which firms adjust their import volumes in response to changes in import costs.

Distributional Effects. We now turn to the distributional effects of import cost changes. In this case, markup changes play a critical role in determining profit changes. The equivalent variation for the owners of importer firms, dC^M, is given by:

$$dC^M = \sum_g \sum_f \left[(p_{gf} - c_{gf})dq_{gf} + q_{gf}(dp_{gf} - dc_{gf})\right] - (\bar{\mu} - 1)m(\sum_g \sum_f q_{gf} dp_{gf}) \quad (7)$$

[15] Note that, because $d \log q^D = 0$, uniform tariff changes do not affect welfare in our model. This follows from the assumptions of segmented factor markets and nested domestic demand, which help us highlight that importer market power generates aggregate implications through resource reallocation across importer firms. As we discuss below, relaxing either assumption would result in the average tariff change having a distinct impact on aggregate welfare through reallocation across domestic and importer firms.

where the sum in the first term is over imported goods and in the second term is over imported and domestic goods. We denote $m \equiv M/E$ as the import-to-expenditure ratio. The first term is the change in profits for all importers, which has two component: (i) the change in imports given initial markup distortions and (ii) the change in markup distortions given initial imports. As such, it contains the changes in allocative efficiency behind the shock's aggregate effect in (5). The second term is the change in consumption costs caused by changes in the price of imported and domestic goods. It is multiplied by the share of owners of importer firms in aggregate expenditure, $(\bar{\mu}-1)m$.

In combination with the expressions for the changes in markups and imports ($d\log\mu_{gf}$ and $d\log q_{gf}$ in (2)–(3)), equation (7) can be written in terms of variables in the initial equilibrium and import cost changes:

$$\begin{aligned}\frac{dC^M}{M} &= \left(1-\frac{(\bar{\mu}-1)(1-\bar{\mu}m)}{\eta\bar{\mu}}\right)\frac{dC}{M} \\ &- E_g\left[E_{f|g}\left[\frac{\mu_{gf}}{\bar{\mu}}\beta^{\mu}_{gf}(d\log c_{gf}-d\log c_g)\right]\right] \\ &+ E_g\left[E_{f|g}\left[\left(\frac{\mu_{gf}}{\bar{\mu}}-1\right)d\log c_{gf}\right]\right]\end{aligned} \tag{8}$$

The first component in (8) is proportional to the aggregate effect as it measures the shock's impact on real profits through import reallocation across goods and firms, conditional on initial markups. The multiplier in parenthesis is strictly positive and accounts for the shares of import profits in aggregate income and import expenditure in consumption. The other two components measure how owners' welfare responds to the shock-induced changes in markups (second row) and import costs (third row).

2.4 Extensions

We now discuss extensions of our main results. In Appendix A.3.3, we present derivations for the general case of changes in both tariffs and world prices starting from any initial equilibrium. As equation (A.36) shows, world price changes and initial tariffs introduce two additional components into dC: changes in allocative efficiency due to initial distortions caused by import tariffs and improvements in the economy's terms of trade. These two terms are present in any neoclassical economy in which import tariffs are the only source of distortions – e.g., Fajgelbaum et al. (2020) and Adão et al. (2024).

Appendix B presents extensions of our baseline model. In all cases, versions of equations (5) and (7) remain valid, attesting to the robustness of our main insight regarding the implications of import firm concentration for tariff incidence. However, each additional mechanism affects $d\log\mu_{gf}$ and $d\log q_{gf}$.

We first extend our model to incorporate an integrated labor market for all firms and endogenous world prices of exported and imported goods. In this case, a wage response triggered by changes in export prices leads to a uniform production increase among domestic firms. This increase is proportional to the average tariff change and impacts welfare through the difference in the average markup between importer and domestic firms. Additionally, tariff changes influence the neoclassical component of welfare associated with terms of trade. To measure tariff incidence in this model, we must also know the initial aggregate payroll of exporter and importer firms, as well as the elasticity parameters of the export demand and import supply curves.

In our second extension, we consider a multi-sector model in which domestic firms use varieties supplied by both domestic and importer firms as intermediate inputs. Since (5) remains valid, intermediate production affects aggregate welfare only through production reallocation across firms. In this case, changes in imported input costs induce changes in marginal costs for domestic firms, which drive reallocation between domestic and importer firms within and across sectors. This effect is captured by a sector-specific average tariff, which summarizes input-output linkages in the economy.

Our third extension allows for a flexible substitution structure across goods while maintaining the assumption of CES demand across firms. This framework captures the idea that imported goods are not equally substitutable for all domestic goods. Firm-level markups and elasticities remain governed by the relationships in Section 2.2. Intuitively, the sensitivity of firm-level import responses to their size reflects competitive pressure in domestic markets through the firm's perceived demand elasticity, which still determines the firm's markup. However, in general equilibrium, we must account for reallocation between domestic and imported goods due to demand substitution. This requires employment data for domestic firms and the estimation of the good-level demand function.

Our final extension assumes homothetic single-aggregator preferences across firms, as in Matsuyama (2023). In our oligopolistic setting, this implies that identification of markups for importer firms requires estimates of firm-level import and price elasticities. Given these elasticities, our analysis proceeds as above.[16]

[16]We note that either prices or imports would suffice if importer firms operate in monopolistic competition, as in Baqaee et al. (2024). The reason is that, in this case, there is no distinction between the firm's perceived demand elasticity and its demand elasticity given the single aggregator.

3 Importer Firm Concentration Across Countries

We established above that tariff incidence depends on the variation of import cost changes across firms and goods with heterogeneous markup levels and import elasticities. In our model, this heterogeneity is intrinsically related to the distribution of firm import shares. Accordingly, we now use a sample of firm-level imports from 57 countries to examine import firm concentration both within and between goods.

3.1 Data

Our database covers the universe of import transactions for each firm and good across 57 countries from 1997 to 2022.[17] We restrict the sample to six-digit goods in the Harmonized System Classification (HS6) that are not in the oil sector.[18] The database has information on the quantity, value (in U.S. dollars), and origin country of each import transaction of HS6 goods and importer firms in a destination country. For a given destination country and year in our sample, we measure each firm's import share of a good as the value of the firm's imports of an HS6 good divided by the total value of the country's imports of that HS6 good in that year.

We start with descriptive statistics on importer firm concentration. The left panel of Figure 3 presents the histogram of firm import shares across all firm-good-country-year observations in our sample.[19] The histogram reveals that most firms account for only a small fraction of their country's imports of HS6 goods. Nearly 90% of the firms in our sample hold less than 10% of the import share of a good in their country, while only 2.7% account for more than 90% of their country's imports of a good.

The right panel of Figure 3 illustrates the distribution of a country's total imports associated with firms holding different levels of the share of a good's imports in their country.[20] Despite the large number of small importer firms, the right-skewness of the

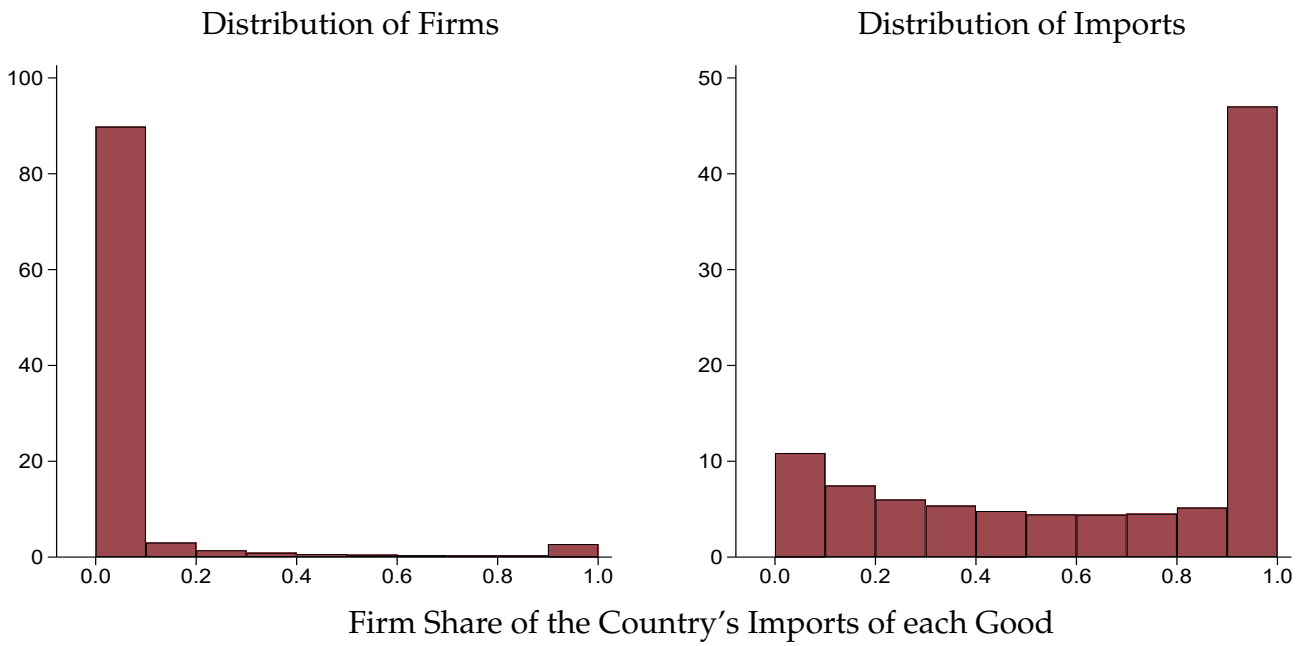
[17] Appendix Table C.1 lists the countries and years in our database. The sample period differs across countries depending on data availability. The transaction-level data was provided to the World Bank in the context of the expansion to the Exporter Dynamics Database project (described by Fernandes et al. (2016)) by each country's customs agency, except for India, Mexico, Sri Lanka and Vietnam which are from S&P's Global Market Intelligence Panjiva data platform.

[18] We use a time-consistent consolidated classification that concords and harmonizes across several HS revisions in the raw data. We exclude oil goods (HS ch. 27) because they are poorly recorded in customs data.

[19] To ensure equal weighting of observations across goods, countries, and years, we weight all importer firms of a good-country-year by that good-country-year's share of the country-year's total imports, normalized by the good-country-year's share of the total number of firms in the database.

[20] This distribution is calculated by weighting each firm-good-country-year observation by its share of the country-year's imports. Again, to ensure equal weighting across good-country-year observations, we

Figure 3: Distribution of Firms and Imports by Firm Import Share



Notes: Sample of 158,121,069 firm-good-country-year observations. Left panel reports the fraction of observations by bracket of the firm's import share of a good (i.e., the imports of the firm-good-country-year divided by imports of the good-country-year), where the weight of all firms of each good-country-year is the good-country-year's share of the country-year's total imports divided by the good-country-year's share of the number of firms in the database. The right panel reports the share of a country's total imports associated with firms in different brackets of the firm's good import share. It is a histogram of firm-good-country-year observations where the weight of each observation is its share of the imports of the country-year divided by the good-country-year's share of the number of firms in the database.

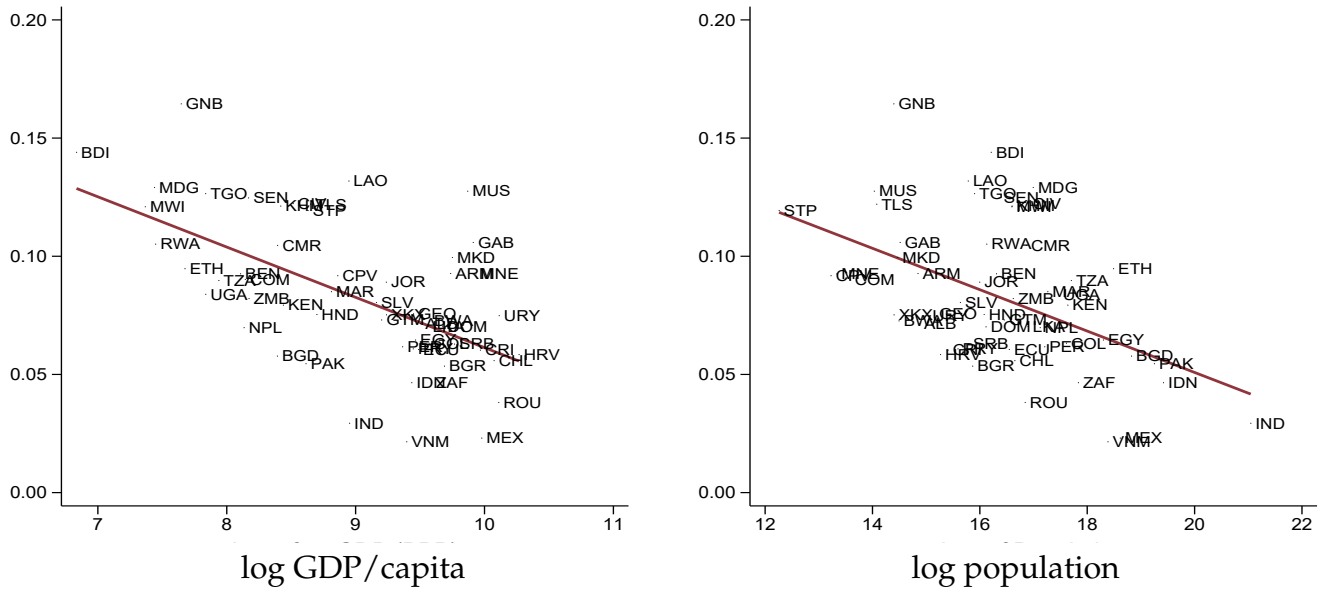
distribution in the right panel highlights that a few large importer firms account for the majority of the country's imports. Close to 50% of the country's imports correspond to goods imported by firms holding more than 90% of the import share of that good.

3.2 Within-Good Dispersion in Import Firm Concentration

We now turn to the dispersion of import shares across firms within each imported good. In our model, this reflects within-good dispersion in elasticity-adjusted markups across importer firms, which appear in the covariance term of the second component of (6). Specifically, we first calculate the standard deviation of import shares across firms for each good-country-year. Then, for each country and year, we define the import-weighted average of this statistic across goods as our measure of within-good dispersion in import firm concentration.

normalize weights by the good-country-year's share of the total number of firms in the dataset.

Figure 4: Within-Good Dispersion in Importer Firm Concentration Across Countries



Note: Figure shows the average of within-good dispersion in importer firm concentration in a country against log GDP per capita (left panel) or log population (right panel) in our sample of 57 countries. For each country, we compute within-good dispersion in importer firm concentration as the simple average across years of the import-weighted average of the standard deviation of firm import shares within a HS6 good-country-year.

Figure 4 shows the cross-country scatter plot of within-good dispersion in import firm concentration against GDP per capita (left panel) and population (right panel), where each value is the variable's simple average across years in our sample. It indicates that there is substantial dispersion in firm import shares within a product, with a median of 7.9 p.p. in our sample of countries. It also shows that within-good dispersion in import firm concentration is higher in poorer and smaller countries. This evidence suggests that tariff changes that have a differential impact across firms importing the same product will have a larger aggregate effect in poorer and smaller countries.

Table 1 examines the robustness of the univariate relationships in Figure 4. The first column reports coefficient estimates from a regression of the standard deviation of firm import shares in a good-country-year on the two variables of interest after controlling for good-year fixed effects to account for the composition of imported goods in each country-year. We obtain estimated coefficients on log GDP per capita and log population that are negative and precise. The second column shows that these relationships are not fully explained by the size of the import market, measured as the log imports in the good-country-year. Lastly, the third column also controls for good-country fixed effects, so that we only exploit variation over time for the same country and good. This leads to point

estimates that are even more negative albeit less precisely estimated.

Table 1: Within-Good Dispersion of Import Firm Concentration vs. GDP/capita and Population

	St. dev. of firm import shares		
log GDP/capita	-0.023***	-0.015***	-0.052***
	(0.002)	(0.002)	(0.012)
log Population	-0.016***	-0.010***	-0.051***
	(0.001)	(0.001)	(0.015)
log Imports		-0.007***	0.003***
		(0.001)	(0.001)
R^2	0.587	0.590	0.848
Fixed Effects:			
HS6-Country	No	No	Yes
HS6-Year	Yes	Yes	Yes

Note: Table reports regressions of the standard deviation of firm import shares of each HS6-country-year on the variables listed on the rows from a sample of 2,498,588 HS6-country-year observations. All regressions include HS6-year fixed effects. Observations weighted by its share of the country's imports in a given year. Standard errors clustered by country. *** p<0.01, ** p<0.05, * p<0.1

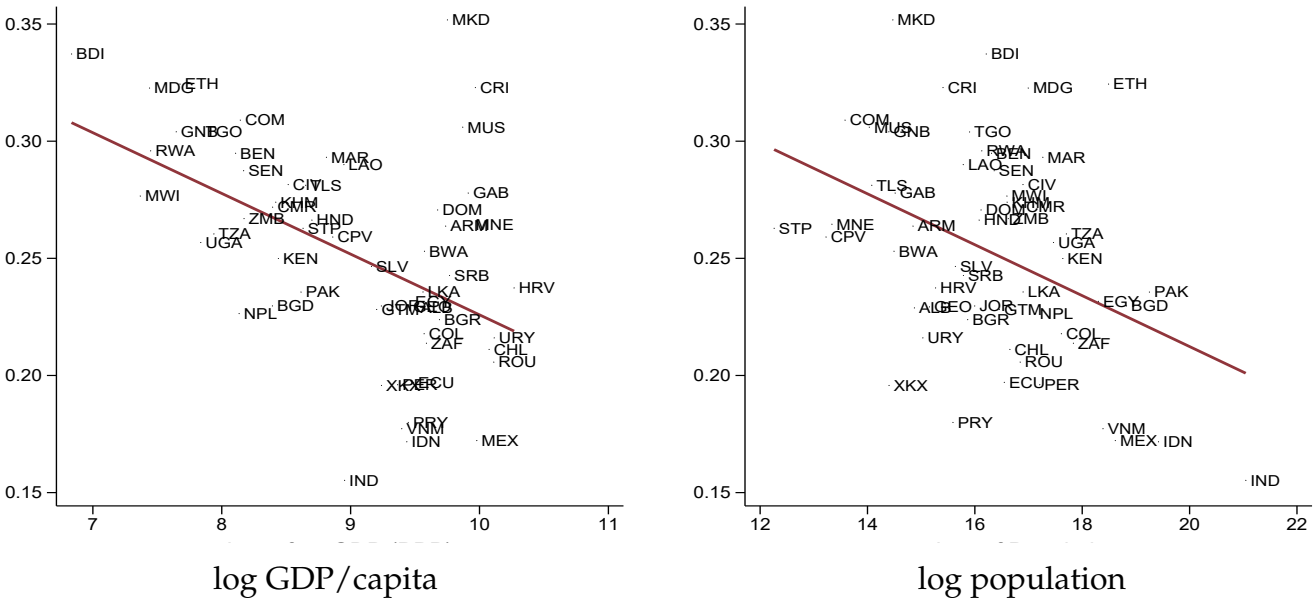
3.3 Between-Good Dispersion in Import Firm Concentration

We next examine the dispersion of import firm concentration across goods. In our model, differences in the Herfindahl-Hirschman Index (HHI) of firm import shares across goods are intrinsically linked to differences in average markups, which appear in the covariance term of the first component of (6).[21] Accordingly, we measure the HHI of each imported good in a country-year as the sum of the squared import shares across importers of that good. For each country, our measure of between-good dispersion in import firm concentration is the import-weighted standard deviation of the HHI across goods.[22]

[21] To see this, consider a first-order approximation of a firm's markup around that of a firm with a negligible import share ($m \approx 0$): $\mu_{gf} = \sigma/(\sigma-1) + \kappa m_{gf}$ with $\kappa > 0$. In this case, $\bar{\mu}_g \equiv \sigma/(\sigma-1) + \kappa \text{HHI}_g$, where $\text{HHI}_g \equiv \sum_f (m_{gf})^2$ is the HHI of import shares across importers of good g.

[22] To prevent differences driven by variation in the composition of imported goods across countries and years, we only consider the subset of 1,749 HS6 products that all countries import in all years. Appendix Table C.2 shows that our conclusions are qualitatively similar when we consider all goods imported by each country-year.

Figure 5: Between-Good Dispersion in Import Firm Concentration Across Countries



Note: Figure shows between-good dispersion in importer firm concentration in a country against log GDP per capita (left panel) or log population (right panel) from our sample of 57 countries. For each country, we compute between-good dispersion in importer firm concentration as the simple average across years of the import-weighted standard deviation across HS6 goods of their HHI of firm import shares.

Figure 5 presents a scatter plot of each country's between-good dispersion in import firm concentration against log GDP per capita (left panel) and log population (right panel), where we again report values averaged across years in our sample. The figure reveals that dispersion in HHI across products is high in our sample and even more pronounced in poorer and smaller countries. Viewed through the lens of our model, this finding suggests greater heterogeneity in average markups across goods in these countries, implying a larger potential for allocative efficiency gains across goods.

Table 2 probes the robustness of this result. The first column introduces log GDP per capita and log population in the same regression, and shows that the negative relationships in Figure 5 hold for both variables simultaneously. The second column shows that these findings hold conditional on the country's trade openness. The last column shows that, when controlling for country fixed effects, coefficients are again larger in magnitude, but less precise.

In summary, we find significant heterogeneity in concentration both within and between goods in our customs data from 57 countries. Furthermore, the magnitude of both dispersion dimensions is greater in poorer and smaller countries.[23] Through the lens

[23] In addition, Appendix C.3.2 shows that the average concentration across all imported goods is greater

Table 2: Between-Good Dispersion in Import Firm Concentration vs. GDP/capita and Population

	St. dev. of HHI across goods		
log GDP/capita	-0.043***	-0.046***	-0.102**
	(0.004)	(0.010)	(0.048)
log Population	-0.016***	-0.018**	-0.119*
	(0.003)	(0.008)	(0.067)
log Imports		0.002	0.029
		(0.008)	(0.021)
R^2	0.472	0.472	0.754
Fixed Effects:			
Country	No	No	Yes
Year	Yes	Yes	Yes

Note: Table report regressions of the import-weighted standard deviation of HHI of a HS6 good across the subset of common HS6 goods for each country-year on log GDP per capita and log population from a sample of 704 country-year observations. All regressions include year fixed effects. Standard errors clustered by country. *** p<0.01, ** p<0.05, * p<0.1

of our model, these findings suggest that, due to changes in allocative efficiency, trade shocks have the potential to generate larger aggregate and distributional effects in poorer and smaller countries.

4 Estimates of Import Responses to Tariff Changes

In this section, we estimate how firms adjust their import decisions in response to tariff changes. From these estimates, we infer the level and sensitivity of the domestic markup of each importer firm based on its share of the country's imports of a good.

4.1 Data

Our main data source for firm-level import outcomes is the customs dataset introduced in Section 3.1. For each HS6 good g from origin o in destination d and year t, the dataset contains information on firm f's tariff-exclusive import value, $v_{ogfd,t}$, and import quantity, $q_{ogfd,t}$. We use these variables to define the unit import value (i.e., the world price) of

in poorer and smaller countries.

each firm's imports as $p^W_{ogfd,t} \equiv v_{ogfd,t}/q_{ogfd,t}$. In addition, we use data from Teti (2020) to obtain information on ad-valorem import tariffs, $\tau_{ogd,t}$, applied to each origin o and good g by the destination country d in year t.[24] This enables us to compute the firm's tariff-inclusive import expenditure, $M_{ogfd,t} = (1+\tau_{ogd,t})v_{ogfd,t}$ and $M_{gfd,t} = \sum_o M_{ogfd,t}$, and the associated import shares, $m_{ogfd,t} = M_{ogfd,t}/M_{gfd,t}$ and $m_{gfd,t} = M_{gfd,t}/\sum_{f'} M_{gf'd,t}$.

4.2 Between-Origin Elasticity of Firm Imports to Tariff Changes

We start by estimating how firms adjust the origin of their imports of a good in response to tariff changes. For each horizon h, we consider the following specification:

$$\Delta^h \log Y_{ogfd,t} = \theta^h \Delta^0 \log(1+\tau_{ogd,t}) + \delta^h_{og,t} + \phi^h_{gfd,t} + \epsilon^h_{ogfd,t} \tag{9}$$

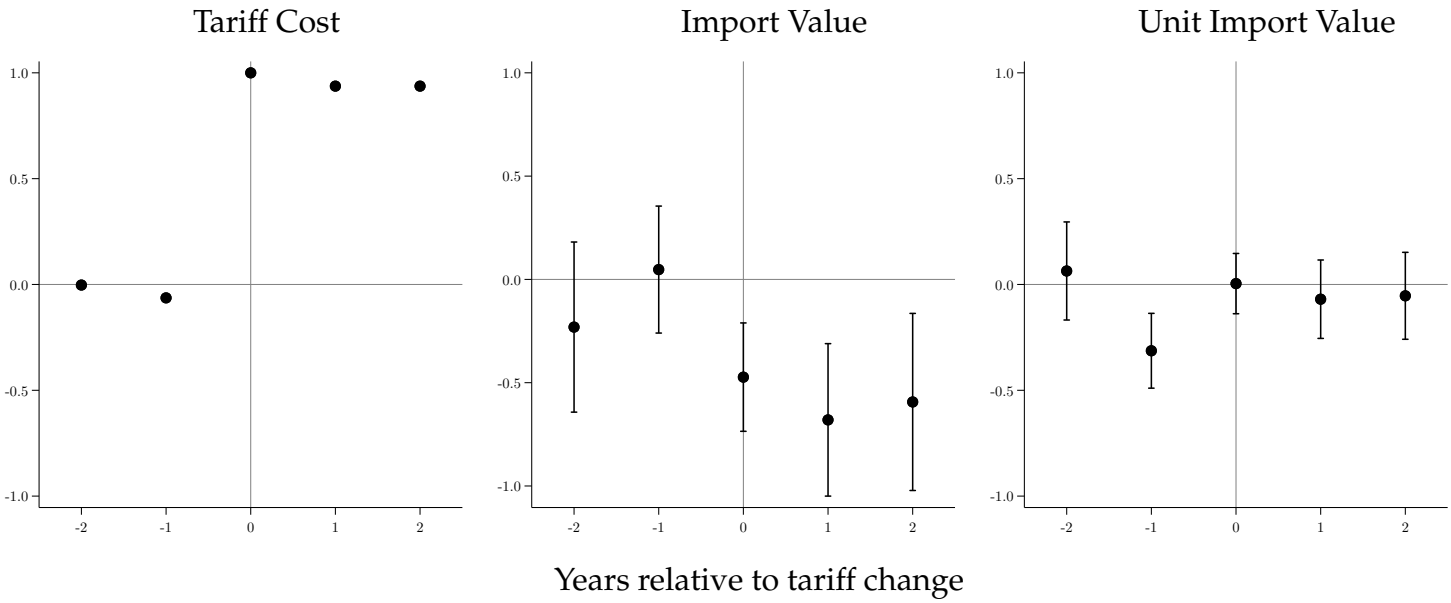
where $\Delta^h \log Y_{ogfd,t}$ denotes the log-change in outcome Y from $t-1$ to $t+h$ for years after t (i.e., $h \geq 0$) and from $t+h-1$ to $t+h$ for years before t (i.e., $h < 0$). Our specification includes fixed effects for each origin-good-year ($\delta^h_{og,t}$) and good-firm-destination-year ($\phi^h_{gfd,t}$). To obtain estimates that are comparable to those based on bilateral trade flows in the literature, we weight observations for each firm by its lagged share of imports from origin o of good g in destination d.

Given the set of fixed-effects in (9), our main identification assumption is that changes in the tariffs that a destination applies to an origin-good pair are not related to firm-specific shocks in the demand for the imports from that origin-good pair. Under this assumption, the OLS estimation of (9) recovers the between-origin elasticity over horizon h of firm-level import outcomes in response to tariff changes, θ^h. When the dependent variable is the tariff-exclusive import value, estimates of θ^h correspond to the between-origin elasticity of substitution within each firm θ, since world prices are exogenous in our model.

Figure 6 presents the estimates of (9) in our sample of 19,509,926 origin-good-firm-destination-year observations. The left panel reports estimates with the dependent variable defined as the change in tariffs over different horizons. In our sample, tariff changes resemble one-time shocks. In the pre-shock years, we estimate only a minor change from $t-2$ to $t-1$ whose magnitude is equivalent to -10% of the change from $t-1$ to t. At year t, the coefficient is equal to one by construction. Afterwards, our estimates suggest a

[24] We obtain tariff data for the following subset of countries in our database: Bulgaria (BGR), Colombia (COL), Costa Rica (CRI), the Dominican Republic (DOM), Ecuador (ECU), Egypt (EGY), Croatia (HRV), Morocco (MAR), Peru (PER), Paraguay (PRY), Romania (ROU), Tanzania (TZA), and Uruguay (URY). For each of these countries, our sample includes the subset of the years listed in Appendix Table C.1 that are between 2001 and 2017.

Figure 6: Between-Origin Elasticity of Firm Imports to Tariff Changes



Note: Figure shows estimates and 95% confidence intervals of cumulative change of the dependent variable (θ^h in equation (9)) relative to the year of the tariff change (denoted by the vertical line at 0) from sample of 19,509,926 origin-HS6-firm-destination-year observations. The dependent variables are the log-change in tariff cost ($\Delta^h \log(1+\tau_{ogd,t})$), tariff-exclusive import value ($\Delta^h \log v_{ogfd,t}$), and unit import value ($\Delta^h \log p^W_{ogfd,t}$) in the left, middle, and right panels, respectively. The log change in the tariff cost at year 0 is 1 by construction. All regressions weight observations for each firm by its lagged share of imports from origin o of good g in country d. Confidence intervals clustered by origin-good and destination-good.

small degree of mean reversal, which is equivalent to 10% of the tariff change from $t-1$ to t.

The middle panel of Figure 6 reports estimates with the dependent variable defined as the change in tariff-exclusive import value. Estimates indicate that tariff changes induce firms to substitute across origins, with an elasticity of roughly 0.5 over one year and 0.6 over three years. In the year prior to the tariff shock, estimates are smaller in magnitude and not statistically significant.

Finally, the right panel of Figure 6 indicates that the unit import value does not respond to tariff changes over all horizons. These findings are consistent with the assumption in our model of exogenous world prices of imported goods, at least within our sample, which is predominantly composed of developing countries.[25]

In terms of magnitude, our estimates closely align with those reported in Boehm et al. (2023) over the same horizons. Since tariffs do not vary across firms, they are directly

[25]Our findings are also consistent with those in Fajgelbaum et al. (2019) and Amiti et al. (2019b). They find that import prices of the United States and China did not respond to the tariff changes during the US-China trade war in 2018-2019.

comparable to Boehm et al. (2023)'s estimates based on good-level trade flows when controlling for fixed effects for good-destination-year instead of firm-good-destination-year. Indeed, Appendix Figure C.2 shows that estimates obtained with good-destination-year fixed effects (red triangles) are similar to our baseline estimates (black circles).[26]

4.3 Between-Firm Elasticity of Imports to Tariff Changes

We now turn to the response in each firm's imports to changes in its average tariff cost. Given exogenous world import prices, equations (1)-(2) imply that

$$\Delta \log v_{gfd,t} = \beta^q(m_{gfd,t-1})(\Delta \log \bar{\tau}_{gfd,t} - \zeta_{gd,t}) + \delta_{gd,t} + \phi_{fd,t} + \epsilon_{gfd,t} \tag{10}$$

such that

$$\Delta \log \bar{\tau}_{gfd,t} \equiv \sum_o m_{ogfd,t-1} \Delta \log(1 + \tau_{ogd,t})$$

with Δ denoting changes from $t-1$ to t. In line with our model, (10) includes good-destination-year fixed effects, $(\zeta_{gd,t}, \delta_{gd,t})$, that account for drivers of import and price changes that are common to all importers of good g in destination d. We also include firm-destination-year fixed effects $\phi_{fd,t}$ to absorb firm-level shocks that are common to all goods imported by the firm, like shocks to the firm's export or domestic demand.

Given the set of fixed-effects in (10), the residual $\epsilon_{gfd,t}$ can be interpreted as unobserved idiosyncratic shocks to the imports of good g by firm f; for example, shocks to the productivity shifters that are specific to the variety of firm f based on imported good g. Accordingly, our identification assumption is that idiosyncratic shocks to imports of a firm-good are orthogonal to changes in tariffs applied to different origins of a good, which generate variation in $\Delta \log \bar{\tau}_{gfd,t}$ across importers of the same good.

Change in average tariff cost across firms. Our estimation strategy exploits the fact that, since tariffs vary across origin-good pairs, firms that import the same good from different origins may face different changes in their average tariff costs. Accordingly, Appendix Figure C.4 shows the frequency of $\Delta \log \bar{\tau}_{gfd,t}$ across firm-good-destination-year observations in our sample, residualized from good-destination-year fixed effects. There would be no variation across firms in their residualized change in average tariff cost if either all firms imported a good from the same origin or if all origins of a good

[26] Appendix Figure C.3 implements the IV strategy in Boehm et al. (2023) that leverages MFN tariff changes in a subsample of small trade partners of each good. In line with their estimates, the IV strategy leads to estimates that are slightly larger in magnitude.

experienced the same tariff change. However, the left panel of the figure shows that a large number of firms experience sizeable changes in their average tariff cost relative to other importers of the same good. There are 127,156 observations whose absolute change in residualized average tariff cost is larger than 5%.

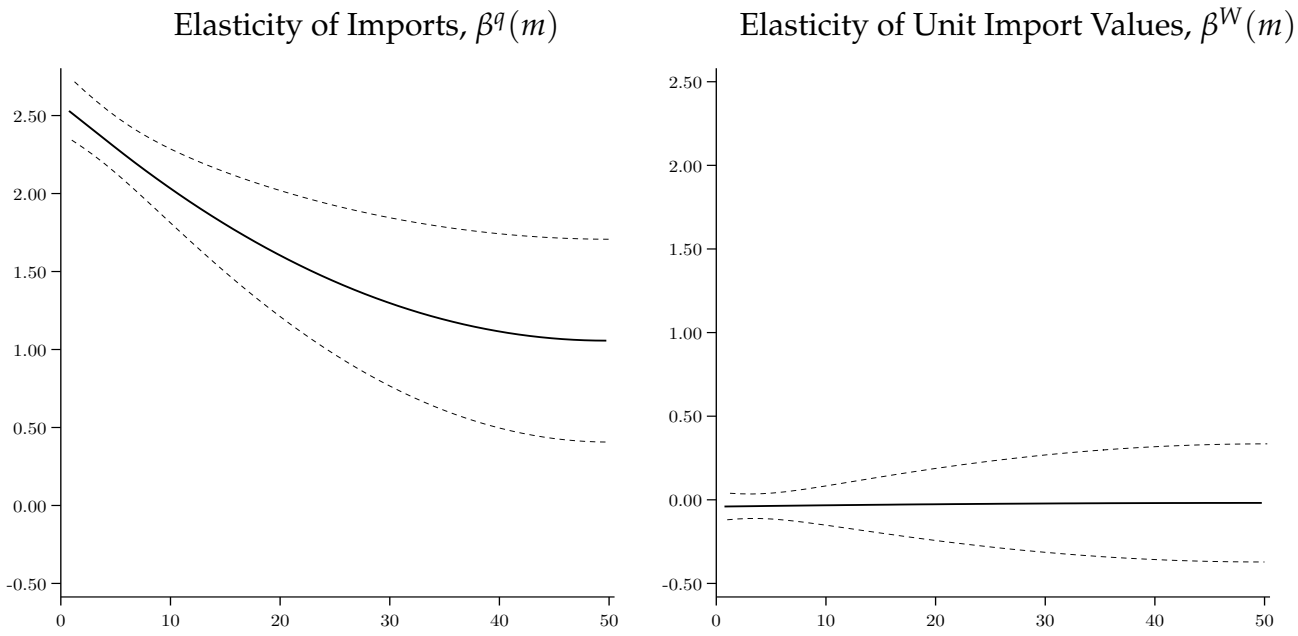
Our estimation strategy also requires changes in average tariff costs across firms that differ in terms of their share of the imports of a good, $m_{gfd,t}$. Section 3 documented that more than 93% of the firms in our database account for less than 20% of their country's imports of a good. We now evaluate the frequency of observations in our sample with sizeable changes in residualized average tariff costs that correspond to large importers of a good. The right panel of Appendix Figure C.4 shows the frequency distribution of the residualized $\Delta \log \bar{\tau}_{gfd,t}$ across firm-good-destination-year observations with $m_{gfd,t-1} \geq 20\%$ and absolute residualized tariff change above 5%. Our sample has 2,748 observations that satisfy these restrictions. The limited variation in tariff cost changes for large importers guides our functional form choices for estimation.[27]

Baseline estimates. The left panel of Figure 7 presents the baseline estimates of (10). The figure shows that firms with a lower import share of a good have a larger elasticity of imports to tariffs, whereas the elasticity of imports is smaller among firms with greater import share of a good. For firms with negligible import shares ($m \approx 0$), an increase of 1 log-point in their tariff cost induces a decline in imports of 2.5 log-points. In contrast, the same shock induces only a reduction of roughly 1 log-point in the imports of goods for which a firm accounts for more than 50% of the destination's imports. Our estimates suggest that import firm concentration shapes how firms respond to tariff changes. They are consistent with the mechanism in our model: larger importers of a good respond less to tariff changes through import changes, but more through domestic markup changes.

The right panel of Figure 7 examines whether the observed pattern of import responses arises from systematic differences across firms in the prices paid to foreign suppliers. To explore this, we estimate a specification analogous to (10), replacing the dependent variable with the log-change in the unit import value of the firm's imports of the good. The results show that the elasticity of unit import values to changes in average tariff costs is close to zero, regardless of the firm's import share of the good. This finding suggests that monopsony power over foreign suppliers is unlikely to be the primary driver of the weaker import decline observed among larger importers, at least within our sample, which is predominantly composed of developing countries.

[27] Appendix C.2 describes the parametrization of $\beta^q(m)$. We use a piece-wise spline that guarantees smooth estimates that are constant beyond a threshold, which we pick to be 50% due to the low number of firms that have both high differential changes in average tariff cost and high import shares of a good.

Figure 7: Firm's Elasticity of Imports and Unit Values to Tariff Changes



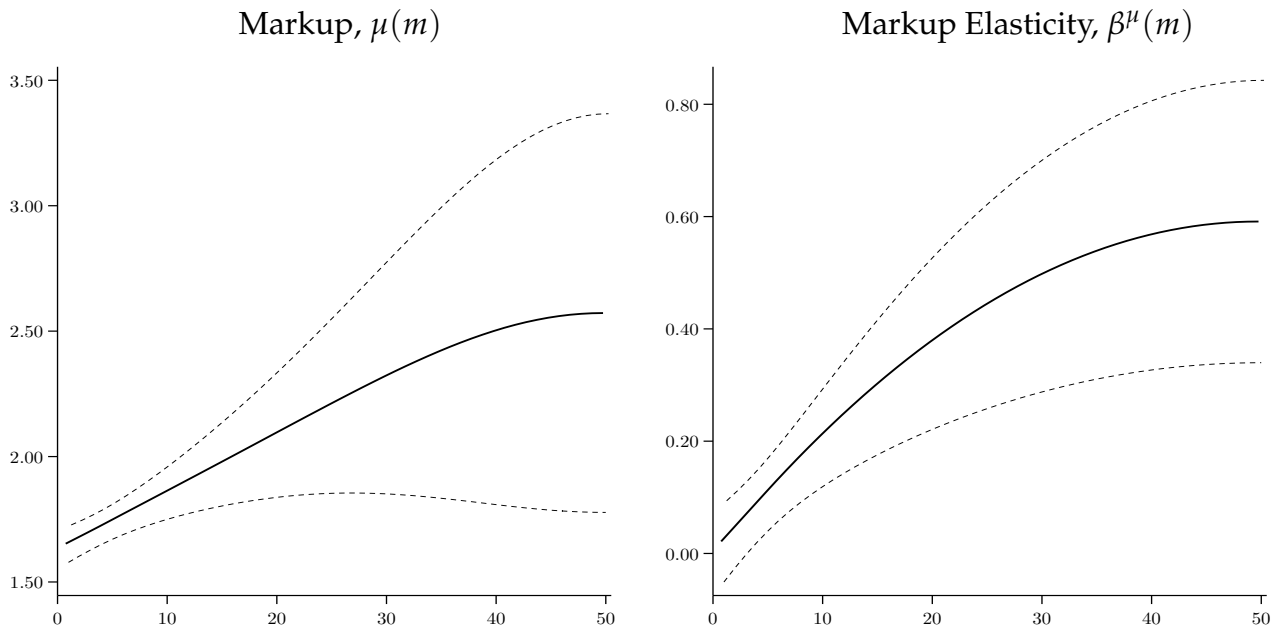
Note: Sample of 13,623,037 firm-good-destination-year observations. Solid line in the right panel is the estimate of $\beta^q(m)$ obtained from (10), along with dashed lines illustrating the 95% confidence intervals implied by standard errors (two-way) clustered by firm-good-destination and good-destination-year. The left panel reports the elasticity function obtained from a specification analogous to (10) where the dependent variable is instead the log-change in the unit import value of the firm's imports of the good.

Through the lens of our model, the estimates of $\beta^q(m)$ identify the level and the sensitivity of the domestic markup of importer firms, since $\mu(m) = \mathcal{M}(\beta^q(m))$ and $\beta^\mu(m) = 1 - \beta^q(m)/\beta^q(0)$. Figure 8 presents our estimates of the domestic markup of importer firms (left panel) and its sensitivity to the firm's import costs (left panel) as a function of the firm's good import share. We find that the domestic markups of small importers is 1.6, with an elasticity to trade costs close to zero. As the firm's import share increases, it sets higher domestic markups that are also more sensitive to trade costs. For firms that account for more than 50% of the destination's imports of a good, the domestic markup is close to 2.5, with an elasticity of -0.6.[28]

Additional estimates. In Appendix Figure C.5, we assess the robustness of our estimates to the choice of fixed effects in (10). The right panel shows that while the estimates

[28]These findings align with the estimates of Amiti et al. (2019a), which show that small firms have an average pass-through from marginal costs to consumer prices of 0.97 (and thus a markup elasticity near zero), whereas the average pass-through among large firms is 0.48 (and thus a markup elasticity near -0.5).

Figure 8: Domestic Markup of Importer Firms



Note: Figure shows point estimates (solid lines) and 95% confidence intervals (dashed lines) of the domestic markup of importer firms (left panel) and the sensitivity of the domestic markup to the firm's average tariff cost (right panel) as a function of the firm's share of its country's imports of a good. Estimates obtained using the elasticity of imports to average tariff costs in the left panel of Figure 7.

remain qualitatively similar, they are slightly smaller in magnitude when we exclude the interaction term $\zeta_{gd,t}$, which captures strategic interactions in domestic price setting driven by price changes among other importers of good g.

Appendix Figure C.5 also investigates potential pretrends by estimating (10) with the dependent variable defined as import changes occurring before the observed tariff adjustment. We find no significant responses between $t-3$ and $t-2$, regardless of the firm's import share. Moreover, larger importers do not adjust their imports in the year preceding the tariff change. However, between $t-2$ and $t-1$, smaller firms exhibit an anticipatory effect, with a magnitude reaching 30% of the impact observed at the time of the tariff change among firms with near-zero import shares.

4.4 Between-Good Elasticity of Imports to Tariff Changes

Next we estimate the elasticity of substitution across imported goods η. Using our estimates of the level and elasticity of markups, we aggregate firm-level changes in imports and tariffs to obtain an expression linking a measure of domestic expenditure on good

g to the tariff-induced change in the price index of good g. Formally, we define the following weighted averages of changes in firm-level imports and tariffs: $\Delta \log v_{gd,t} \equiv \sum_f m_{gfd,t-1}(\mu_{gfd,t-1}/\bar{\mu}_{gd,t-1})\Delta \log v_{gfd,t}$ and $\Delta \log \bar{\tau}_{gd,t} \equiv \sum_f \omega_{gfd,t-1}\Delta \log \tau_{gfd,t}$. Assuming that world prices are exogenous, the aggregation of equation (2) across firms implies that

$$\Delta \log v_{gd,t} = -\eta \Delta \log \bar{\tau}_{gd,t} + \zeta_{d,t} + \epsilon_{gd,t}, \tag{11}$$

where $\zeta_{d,t}$ is a destination-year fixed effect. To compute $\Delta \log v_{gd,t}$ and $\Delta \log \bar{\tau}_{gd,t}$, we use the estimates reported in Section 4.3 to specify $\beta^q_{gfd,t-1} = \beta^q(m_{gfd,t-1})$ and $\mu_{gfd,t-1} = \mu(m_{gfd,t-1})$.

Table C.4 in Appendix C.4 presents estimates of equation (11). Our baseline estimate of η based on variation across all 6-digit HS goods is 1.86 (s.e.=0.38), which is slightly higher than the estimate of 1.53 that Fajgelbaum et al. (2019) obtain for the United States. When we estimate the elasticity across narrower sets of goods, we get η =2.05 (s.e.=0.35) within 2-digit HS goods and η =2.12 (s.e.=0.37) within 4-digit HS goods.

5 Markup Dispersion and Tariff Incidence

In this section, we quantify how markup distortions generated by import firm concentration affect the aggregate and distributional effects of tariff changes. We proceed in three steps. We first combine import elasticities across firms and goods in Section 4 with the import market shares of each firm to impute the dispersion in markups across goods and across firms selling the same good. We then calculate the dispersion of tariff changes across goods and firms and the covariance of the tariff change with the average markup of the good and of the firm. We then put all these ingredients into the tariff incidence formulas in Section 2 to estimate the welfare change from changes in changes in each country.

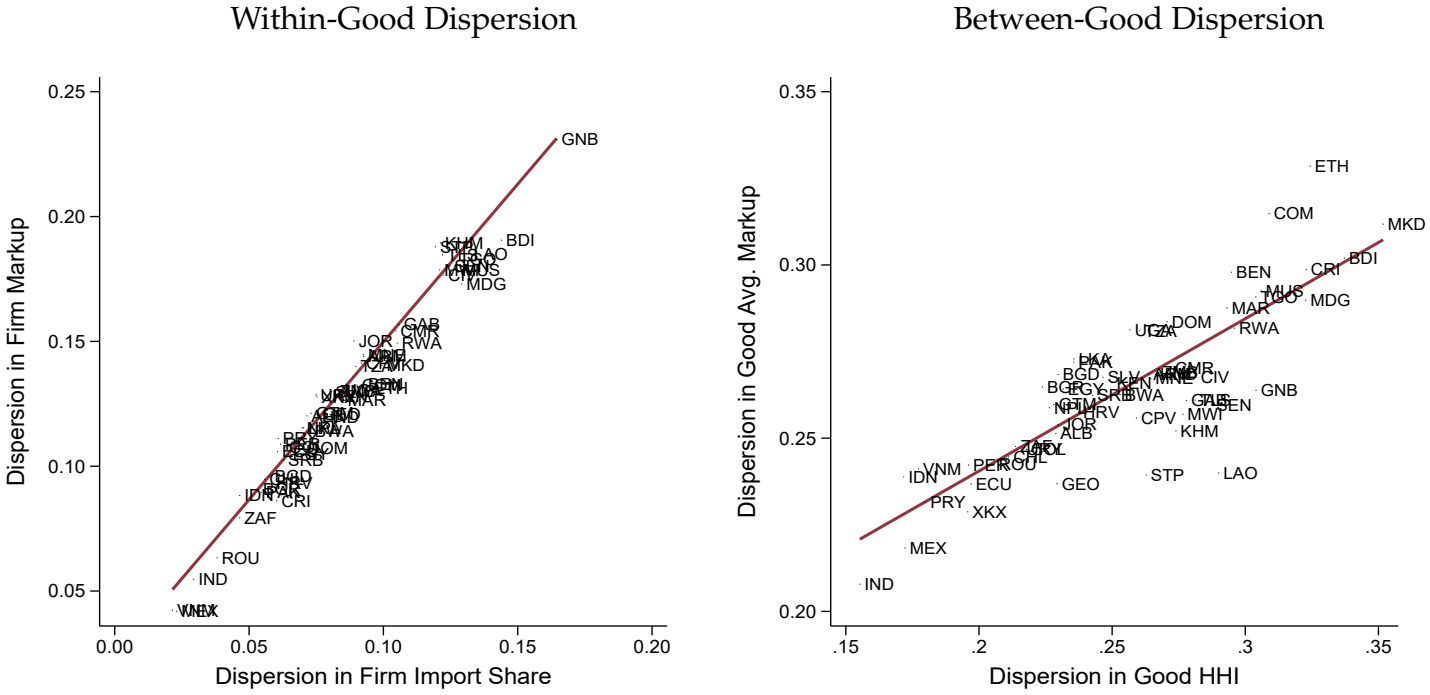
5.1 Within- and Between-Good Dispersion in Markups

We start by showing the magnitude of the within- and between-good heterogeneity in markups in our sample of countries. We use the estimated markup function in Figure 8, along with the data on the import share of each firm in our sample, to impute the markup of each firm. We then measure within-good markup dispersion as the average standard deviation of markups among importers of each good, and the between-good markup dispersion as the average across goods of the average markup among importers of each

good.[29]

Figure 9 shows the dispersion in markups within goods (left panel) and between goods (right panel) on the y-axis and the dispersion in import market concentration (within and between goods) on the x-axis. From the y-axis, we can see the substantial dispersion in markups: across countries in our sample, the median of the standard deviation in markups is 0.13 between goods and 0.26 within goods. The figure also shows the positive relationship between the dispersion in markups and import shares: across countries, the correlations between these measures are 0.84 between goods and 0.99 within goods.

Figure 9: Dispersion in Markups vs. Dispersion in Import Firm Concentration



Note: Sample of 57 countries with import data between 1997 and 2022. Left panel compares the within-good standard deviation of import shares among importers of each good (x-axis) with the within-good standard deviation of firm markups among importers of each good (y-axis). Both measures are aggregated to country-level using import-weighted averages across goods in a given year, and simple averages across years. Right panel compares the import-weighted standard deviation across goods of their HHI of firm import shares (x-axis) with the import-weighted standard deviation across goods of their import-weighted average of firm markups (y-axis). Both measures are aggregated to country-level using simple averages across years.

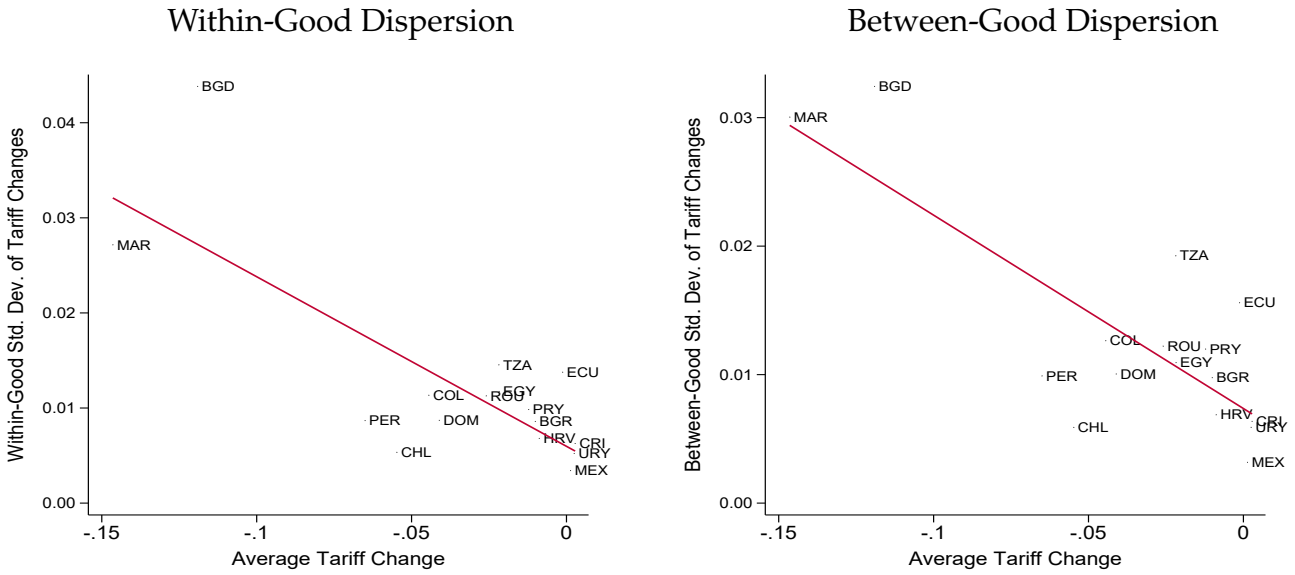
[29]For the two measures, we weight each good by its share of total imports of the country.

5.2 Within- and Between-Good Dispersion in Tariff Changes

We now turn to the dispersion of changes in tariff costs across goods and across importers of the same good. We focus on the subset of 16 countries in our sample for which we also have data on import tariffs between 2001 and 2017.

Figure 10 shows that trade liberalizations that reduce a country's average import tariff also tend to create heterogeneous in import costs both between and within goods. The left panel shows that, in countries with larger average tariff reductions, there is more dispersion of changes in import tariff costs across importers of the same good. Similarly, the right panel indicates that average tariff reductions also give rise to heterogeneous changes in the average tariff of different imported goods. In fact, across the countries in our sample, the correlation between the average tariff change and dispersion in tariff changes is -0.48 within goods and -0.85 between goods.

Figure 10: Dispersion in Tariff Changes vs. Average Tariff Changes



Note: Sample of 16 countries with import data between 2001 and 2017. Left panel compares the within-good standard deviation of changes in import tariff costs among importers of the same good (y-axis) with the import-weighted average of changes in the log of one plus the tariff across origins and goods (x-axis). Within-good dispersion is aggregated to country-level using the import-weighted average across goods in a given year, and the simple average across years. Right panel compares the import-weighted standard deviation across goods of changes in import tariff costs (y-axis) with the import-weighted average of changes in the log of one plus the tariff across origins and goods (x-axis). Between-good dispersion is aggregated to country-level using simple averages across years. Average tariff change aggregated to country-level using the sum across years.

5.3 Aggregate Effect of Tariff Changes

We are now ready to measure the aggregate effect of changes in tariffs in our sample. The left panel in Figure 11 shows the aggregate welfare change normalized by the average tariff change. For each country, we show the total change in welfare as a fraction of initial imports, as well as the change in welfare due to changes in allocative efficiency created by markup distortions (dC/M in (6)), which emerge in our baseline model with heterogeneous markups, and by tariff distortions (dC^{TD}/M in (A.40)), which emerge in neoclassical models where initial tariffs are the only source of distortions.

In almost every country, the welfare gain from an improvement in allocative efficiency associated with markup distortions is at least as large as the gain associated with reductions in tariff distortions. The gain in allocative efficiency comes from the fact that tariff reductions are heterogeneous and generally lower tariffs more for concentrated products and larger importers of a good. The notable exception is Bangladesh, where the trade liberalization had a large negative effect on allocative efficiency due to markup distortions.

The right panel in Figure 11 decomposes the contribution in allocative efficiency of markup distortions into its components associated with reallocation between imported goods and between firms importing the same good. In almost every country, the trade liberalization caused reallocation between firms that improved allocative efficiency. That is, when reduction in trade costs had heterogeneous effects across importing firms selling the same good, trade costs generally fell by more for larger firms compared to smaller firms. The same is not true for between good reallocation. Here, there are some countries where allocative efficiency between goods improved (such as Tanzania) and other countries where it worsened (such as Bangladesh).

6 Conclusion

This paper studied the incidence of tariff changes in the presence of distortions created by the domestic market power of importing firms. We propose a model in which oligopolistic importing firms make strategic domestic pricing decisions based on their import share. We show that a firm's strategic considerations are summarized by the elasticity of its imports to tariff changes, which depends on the firm's share of the country's imports of a given good. Given firm-level pricing decisions, the incidence of tariff changes depends on both the between- and within-good covariance between import responses and initial markups.

To measure the contribution of import firm concentration to the incidence of tariff

Figure 11: Decomposition of Aggregate Welfare Effect of Tariff Changes



Note: Sample of 12 countries with tariff data between 2001 and 2017 and average tariff decline in the period. Left panel reports changes in aggregate welfare, normalized by the average tariff change, along with its components associated with markup distortions, dC^{MD}/M in (A.39), and tariff distortions, dC^{TD}/M in (A.40). The right panel reports the components of the welfare effect of markup distortions: the between-good component is the first term in (6) and the between-firm component is the second term in (6). For each country, we report the sum across years of annual changes in each statistic.

changes, we assembled a dataset of firm-level imports from 57 countries. This dataset reveals that not only are imports of a given good concentrated among a few large importing firms, but also that import firm concentration is higher and more dispersed in poorer and smaller countries. Furthermore, we show that, relative to smaller importers of a given good, larger importers respond less to tariff cost changes and consequently maintain higher domestic markups. By combining our estimates of initial markups and import responses, we decompose welfare changes caused by tariff changes into components associated with markup and tariff distortions. We find that both components are similar in magnitude, but gains in allocative efficiency tend to be larger in poorer and smaller countries due to their higher levels and dispersion of import firm concentration.

References

Adão, Rodrigo, Arnaud Costinot, and Dave Donaldson, "Putting Quantitative Models to the Test: An Application to the US-China Trade War," *The Quarterly Journal of Economics*, 2024, p. qjae041.

_ , John Sturm Becko, Arnaud Costinot, and Dave Donaldson, "Why is Trade Not Free? A Revealed Preference Approach," Technical Report, National Bureau of Economic Research 2023.

Alviarez, Vanessa I, Michele Fioretti, Ken Kikkawa, and Monica Morlacco, "Two-sided market power in firm-to-firm trade," Technical Report, National Bureau of Economic Research 2023.

Amiti, Mary, Oleg Itskhoki, and Jozef Konings, "Importers, exporters, and exchange rate disconnect," *American Economic Review*, 2014, *104* (7), 1942–1978.

_ , _ , and _ , "International shocks, variable markups, and domestic prices," *The Review of Economic Studies*, 2019, *86* (6), 2356–2402.

_ , Stephen J Redding, and David E Weinstein, "The impact of the 2018 tariffs on prices and welfare," *Journal of Economic Perspectives*, 2019, *33* (4), 187–210.

Arkolakis, Costas, Arnaud Costinot, Dave Donaldson, and Andrés Rodríguez-Clare, "The elusive pro-competitive effects of trade," *The Review of Economic Studies*, 2019, *86* (1), 46–80.

Atkeson, Andrew and Ariel Burstein, "Pricing to Market, Trade Costs, and International Relative Prices," *American Economic Review*, 2008, *98* (5), 1998–2031.

Atkin, David and Dave Donaldson, "The role of trade in economic development," in "Handbook of International Economics," Vol. 5, Elsevier, 2022, pp. 1–59.

Baqaee, David R. and Emmanuel Farhi, "Productivity and Misallocation in General Equilibrium," *Quarterly Journal of Economics*, 2020, *135* (1), 105–163.

Baqaee, David Rezza and Emmanuel Farhi, "Networks, barriers, and trade," *Econometrica*, 2024, *92* (2), 505–541.

_ , _ , and Kunal Sangani, "The darwinian returns to scale," *Review of Economic Studies*, 2024, *91* (3), 1373–1405.

Berman, Nicolas, Philippe Martin, and Thierry Mayer, "How do different exporters react to exchange rate changes?," *The Quarterly Journal of Economics*, 2012, *127* (1), 437–492.

Blaum, Joaquin, Claire Lelarge, and Michael Peters, "The gains from input trade with heterogeneous importers," *American Economic Journal: Macroeconomics*, 2018, *10* (4), 77–127.

_ , _ , and _ , "Firm size, quality bias and import demand," *Journal of International Economics*, 2019, *120*, 59–83.

Boehm, Christoph E, Andrei A Levchenko, and Nitya Pandalai-Nayar, "The long and short (run) of trade elasticities," *American Economic Review*, 2023, *113* (4), 861–905.

Broda, Christian, Nuno Limao, and David Weinstein, "Optimal Tariffs and Market Power: The Evidence," *American Economic Review*, 2008, *98* (5), 2032–65.

Burstein, Ariel and Gita Gopinath, "International prices and exchange rates," in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 4 New York: Elsevier 2013.

Costinot, Arnaud and Andres Rodríguez-Clare, "Trade Theory with Numbers: Quantifying the Consequences of Globalization," in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 4, New York: Elsevier, 2014.

Edmond, Chris, Virgiliu Midrigan, and Daniel Yi Xu, "Competition, Markups, and the Gains from International Trade," *American Economic Review*, October 2015, *105* (10), 3183–3221.

Fajgelbaum, Pablo D, Pinelopi K Goldberg, Patrick J Kennedy, and Amit K Khandelwal, "The Return to Protectionism," *The Quarterly Journal of Economics*, 11 2019, *135* (1), 1–55.

Fajgelbaum, Pablo D., Pinelopi K. Goldberg, Patrick J Kennedy, and Amit K Khandelwal, "The Return to Protectionism," *Quarterly Journal of Economics*, 2020, *135* (1), 1–55.

Fernandes, Ana, Caroline Freund, and Martha Pierola, "Exporter Behavior, Country Size and Stage of Development: Evidence from the Exporter Dynamics Database," *Journal of Development Economics*, 2016, *119*, 121–137.

Hall, Robert E, "Market structure and macroeconomic fluctuations," *Brookings papers on economic activity*, 1986, *1986* (2), 285–338.

Harrell, Frank E., *Regression Modeling Strategies: With Applications to Linear Models, Logistic and Ordinal Regression, and Survival Analysis* Springer Series in Statistics, Cham: Springer International Publishing, 2015.

Hsieh, Chang-Tai and Peter J Klenow, "Misallocation and manufacturing TFP in China and India," *The Quarterly journal of economics*, 2009, *124* (4), 1403–1448.

Krugman, Paul, "Increasing Returns Monopolistic Competition and International Trade," *Journal of International Economics*, 1979, *9* (4), 469–479.

Loecker, Jan De and Frederic Warzynski, "Markups and firm-level export status," *American economic review*, 2012, *102* (6), 2437–2471.

__ **and Pinelopi Koujianou Goldberg**, "Firm performance in a global market," *Annu. Rev. Econ.*, 2014, *6* (1), 201–227.

__ **, Pinelopi K Goldberg, Amit K Khandelwal, and Nina Pavcnik**, "Prices, markups, and trade reform," *Econometrica*, 2016, *84* (2), 445–510.

Matsuyama, Kiminori, "Non-CES aggregators: a guided tour," *Annual Review of Economics*, 2023, *15* (1), 235–265.

Teti, Feodora, "30 Years of Trade Policy: Evidence from 5.7 Billion Tariffs," 2020. IFO Working Paper No. 334.

A Theoretical Appendix

A.1 Equilibrium

Notation. The set of domestic goods is $\mathcal{G}^D$, the set of imported goods is $\mathcal{G}^M$, and the set of exported goods is $\mathcal{G}^X$. For each good g, the set of firms producing a variety is $\mathcal{F}_g$. Importer firms varieties of the imported goods from origins in set $\mathcal{O}$.

Domestic Demand. Given preferences, utility maximization implies that domestic demand is given by

$$q_{gf} = (p_{gf})^{-\sigma}(P_g)^{\sigma-\eta}Q \quad \text{with} \quad (P_g)^{1-\sigma} = \sum_f (p_{gf})^{1-\sigma} \tag{A.1}$$

$$Q = P^{\eta-1}E \quad \text{and} \quad P^{1-\eta} = \sum_g (P_g)^{1-\eta}. \tag{A.2}$$

Cost Minimization Problem. For domestic firms, the cost minimization problem implies that the marginal cost is

$$c_{gf} = w/a_{gf}. \tag{A.3}$$

For importer firms, the cost minimization problem under the technology,

$$Y_{gf} = \left[\sum_o (a_{ogf})^{\frac{1}{\theta}} (q_{ogf})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}, \tag{A.4}$$

implies that the marginal cost is given by

$$c_{gf} \equiv \left[\sum_{o\in\mathcal{O}} (a_{ogf})(p_{og})^{1-\theta}\right]^{\frac{1}{1-\theta}}. \tag{A.5}$$

Firm f's imports of good g from origin o are given by

$$q_{ogf} = (a_{ogf})(p_{og}/c_{gf})^{-\theta} q_{gf}. \tag{A.6}$$

Profit Maximization of Domestic Sales. Conditional on its marginal cost c_{gf}, firm f sets its price optimally given the perceived domestic demand:

$$\Pi_{gf} \equiv \max_{p_{gf}, q_{gf}} (p_{gf} - c_{gf}) q_{gf} \quad \text{subject to (A.1)} \tag{A.7}$$

The first-order condition of (A.7) is

$$p_{gf} - (p_{gf} - c_{gf})\varepsilon_{gf} = 0 \quad \text{where} \quad \varepsilon_{gf} \equiv -\frac{\partial \log q_{gf}}{\partial \log p_{gf}}.$$

Thus, the set of equilibrium prices in the economy satisfies the following system:

$$p_{gf} = \mu_{gf} c_{gf} \quad \text{such that} \quad \mu_{gf} = \frac{\varepsilon_{gf}}{\varepsilon_{gf} - 1}, \tag{A.8}$$

where

$$\varepsilon_{gf} = \sigma - (\sigma - \eta) e_{gf} \quad \text{and} \quad e_{gf} = \frac{a_{gf} (p_{gf})^{1-\sigma}}{\sum_{f' \in \mathcal{F}_g} a_{gf'} (p_{gf'})^{1-\sigma}}, \tag{A.9}$$

Note that $\varepsilon_{gf} > 1$ because $\sigma \geq \eta > 1$. This guarantees that the second-order condition of the maximization problem holds.

We denote the firm's revenue and cost in equilibrium by $E_{gf} \equiv p_{gf} q_{gf}$ and $M_{gf} \equiv c_{gf} q_{gf}$, respectively.

Profit Maximization of Export Sales. Given world prices, exporter firms find it optional to supply their endowment and receive profits of

$$\Pi_{gf} = p_g^W x_{gf} \quad \text{and} \quad x_{gf} = z_{gf} \bar{L}_{gf}^X \quad \text{for all} \quad g \in \mathcal{G}^X. \tag{A.10}$$

Budget Balance. The lump-sum transfer to workers and owners is

$$T = \sum_g \sum_f \sum_o \tau_{og} p_{og}^W q_{ogf}. \tag{A.11}$$

Labor Market Clearing. For each exporter firm, $L_{gf}^X = \bar{L}_{gf}^X$. For domestic firms,

$$\bar{L}^D = \sum_{g \in \mathcal{G}^D} \sum_{f \in \mathcal{F}_g} L_{gf} \tag{A.12}$$

Aggregate Expenditure. Spending much be equal to income:

$$E = w \bar{L}^D + \sum_g \sum_f \Pi_{gf} + T. \tag{A.13}$$

Equilibrium. Given tariffs $\{\tau_{og}\}_{o \in \mathcal{O}, g \in \mathcal{G}^M}$, world prices $\{p_{og}^W\}_{o \in \mathcal{O}, g \in \mathcal{G}^M}$ and $\{p_g^W\}_{g \in \mathcal{G}^X}$, the equilibrium is $\{p_{gf}, q_{gf}, c_{gf}\}_{f \in \mathcal{F}_g, g \in \mathcal{G}^D \cup \mathcal{G}^M}$ and $\{w, E\}$ such that (i) consumers maximize their utility, as in (A.1)–(A.2); (ii) firms minimize their costs, as in (A.3)-(A.6); (iii) firms maximize their profits in domestic markets, as in (A.7)–(A.9); (iv) firms maximize their profits in export markets, as in (A.10); (v) the government balances its budget, as in (A.11); and (vi) domestic markets for labor and goods clear, as in (A.12)–(A.13).

A.2 Proofs of Section 2.2

Cross-firm variation in prices, markups, and sales. Holding constant the price index P_g, equation (2.2) implies that

$$\frac{\partial \log p_{gf}}{\partial \log c_{gf}} = 1 + \frac{\partial \log \mu_{gf}}{\partial \log c_{gf}}$$

$$\frac{\partial \log \mu_{gf}}{\partial \log c_{gf}} = -\frac{1}{\varepsilon_{gf}(\varepsilon_{gf}-1)} \frac{\partial \varepsilon_{gf}}{\partial \log p_{gf}} \frac{\partial \log p_{gf}}{\partial \log c_{gf}}$$

$$\frac{\partial \varepsilon_{gf}}{\partial \log p_{gf}} = (\sigma - \varepsilon_{gf})(\sigma - 1)$$

Thus,

$$\frac{\partial \log p_{gf}}{\partial \log c_{gf}} = 1 - \rho_{gf} \frac{\partial \log p_{gf}}{\partial \log c_{gf}} \implies \frac{\partial \log p_{gf}}{\partial \log c_{gf}} = \frac{1}{1+\rho_{gf}}$$

with

$$\rho_{gf} = \frac{(\sigma - \varepsilon_{gf})(\sigma - 1)}{\varepsilon_{gf}(\varepsilon_{gf} - 1)}.$$

This implies that

$$\frac{\partial \log q_{gf}}{\partial \log c_{gf}} = -\sigma \frac{\partial \log p_{gf}}{\partial \log c_{gf}} = -\frac{\sigma}{1+\rho_{gf}}$$

$$\frac{\partial \log \mu_{gf}}{\partial \log c_{gf}} = \frac{\partial \log p_{gf}}{\partial \log c_{gf}} - 1 = -\frac{\rho_{gf}}{1+\rho_{gf}}$$

$$\frac{\partial \log E_{gf}}{\partial \log c_{gf}} = \frac{\partial \log p_{gf} q_{gf}}{\partial \log c_{gf}} = \frac{1-\sigma}{1+\rho_{gf}}$$

$$\frac{\partial \log M_{gf}}{\partial \log c_{gf}} = \frac{\partial \log c_{gf} q_{gf}}{\partial \log c_{gf}} = 1 - \frac{\sigma}{1+\rho_{gf}}$$

Note that $\sigma \geq \eta > 1$ implies that $\sigma \geq \varepsilon_{gf}, \rho_{gf} \geq 0$, $\frac{\partial \log p_{gf}}{\partial \log c_{gf}} \in (0,1]$, $\frac{\partial \log \mu_{gf}}{\partial \log c_{gf}} \in (-1,0]$, $\frac{\partial \log q_{gf}}{\partial \log c_{gf}} \in [-\sigma, 0)$, and $\frac{\partial \log E_{gf}}{\partial \log c_{gf}} \in [1-\sigma, 0)$. Finally, we note that

$$\frac{\partial \log M_{gf}}{\partial \log c_{gf}} = \frac{1-\sigma+\rho_{gf}}{1+\rho_{gf}} = \frac{\sigma-1}{1+\rho_{gf}} \left(\frac{(\sigma - \varepsilon_{gf})}{\varepsilon_{gf}(\varepsilon_{gf}-1)} - 1 \right) = \frac{\sigma-1}{1+\rho_{gf}} \frac{\sigma - (\varepsilon_{gf})^2}{\varepsilon_{gf}(\varepsilon_{gf}-1)},$$

which implies that $\frac{\partial \log M_{gf}}{\partial \log c_{gf}} < 0 \Leftrightarrow (\varepsilon_{gf})^2 > \sigma$. Since $\varepsilon_{gf} \in [\eta, \sigma]$, this condition is satisfied if $\eta < \sigma < \eta^2$.

Mapping from β^q_{gf} to μ_{gf}. To simplify notation, we drop subscripts for goods. The definition of β^q_f in (2.2) implies that

$$\beta^q_f = \frac{\sigma}{1 + \frac{(\sigma - \varepsilon_f)(\sigma-1)}{\varepsilon_f(\varepsilon_f - 1)}},$$

which yields the following quadratic equation:

$$(\sigma - \beta_f^q)(\varepsilon_f)^2 - (1 - \beta_f^q)\sigma\varepsilon_f - \beta_f^q(\sigma - 1)\sigma = 0.$$

Since $\beta_f^q \in (0, \sigma]$, the positive real root is

$$\varepsilon_f = \frac{(1 - \beta_f^q)\sigma + \sqrt{\left((1 - \beta_f^q)\sigma\right)^2 + 4(\sigma - \beta_f^q)\beta_f^q(\sigma - 1)\sigma}}{2(\sigma - \beta_f^q)}.$$

If $\varepsilon_f > 1$, we can then compute $\mu_f = \varepsilon_f/(\varepsilon_f - 1)$. Thus, $\mu_f = \mathcal{M}(\beta_f^q)$ such that

$$\mathcal{M}(\beta) \equiv \frac{\varepsilon(\beta)}{\varepsilon(\beta) - 1} \tag{A.14}$$

where

$$\varepsilon(\beta) \equiv \frac{(1 - \beta)\sigma + \sqrt{((1 - \beta)\sigma)^2 + 4(\sigma - \beta)\beta(\sigma - 1)\sigma}}{2(\sigma - \beta)}. \tag{A.15}$$

It only remains to show that $\varepsilon_f > 1$. Indeed, since $\beta \in (0, \sigma]$, $\varepsilon > 1$ is equivalent to

$$(1 - \beta)\sigma + \sqrt{((1 - \beta)\sigma)^2 + 4(\sigma - \beta)\beta(\sigma - 1)\sigma} > 2(\sigma - \beta)$$

$$\sqrt{((1 - \beta)\sigma)^2 + 4(\sigma - \beta)\beta(\sigma - 1)\sigma} > 2(\sigma - \beta) + (\beta - 1)\sigma$$

$$((1 - \beta)\sigma)^2 + 4(\sigma - \beta)\beta(\sigma - 1)\sigma > ((\beta - 1)\sigma)^2 + 4(\beta - 1)\sigma(\sigma - \beta) + 4(\sigma - \beta)^2$$

$$(\sigma - \beta)\beta(\sigma - 1)\sigma > (\beta - 1)\sigma(\sigma - \beta) + (\sigma - \beta)^2$$

$$\beta(\sigma - 1)\sigma > (\beta - 1)\sigma + (\sigma - \beta)$$

$$\beta(\sigma - 1)\sigma > \beta(\sigma - 1)$$

$$\sigma > 1$$

A.3 Proofs of Section 2.3

We now derive the first-order approximation for the economy's response to an arbitrary change in tariffs τ_{og} and world import prices p_{og}^W.

A.3.1 Firm-level Responses

Let us write the price of each firm as an implicit function, $p_{gf} = \mathcal{P}_g(c_{gf}, P_g)$, characterized by the solution of

$$p_{gf} = \frac{\sigma - (\sigma - \eta) a_{gf} \left(\frac{p_{gf}}{P_g}\right)^{1-\sigma}}{\sigma - 1 - (\sigma - \eta) a_{gf} \left(\frac{p_{gf}}{P_g}\right)^{1-\sigma}} c_{gf}.$$

Thus, the total differentiation of this system implies that

$$\begin{aligned} d\log p_{gf} &= \tfrac{\partial \log p_{gf}}{\partial \log c_{gf}} d\log c_{gf} + \tfrac{\partial \log p_{gf}}{\partial \log P_g} d\log P_g \\ &= \tfrac{1}{1+\rho_{gf}} d\log c_{gf} + \tfrac{\partial \log p_{gf}}{\partial \log P_g} d\log P_g \end{aligned}$$

where we use the fact that $\frac{\partial \log p_{gf}}{\partial \log c_{gf}} = \frac{1}{1+\rho_{gf}}$.

To derive an expression for $\frac{\partial \log p_{gf}}{\partial \log P_g}$, we first note that

$$\begin{aligned} \frac{\partial \log p_{gf}}{\partial \log P_g} &= \frac{\partial \log \mu_{gf}}{\partial \log p_{gf}} \frac{\partial \log p_{gf}}{\partial \log P_g} + \frac{\partial \log \mu_{gf}}{\partial \log P_g} \\ &= -\frac{1}{\varepsilon_{gf}(\varepsilon_{gf} - 1)} \left(\frac{\partial \varepsilon_{gf}}{\partial \log p_{gf}} \frac{\partial \log p_{gf}}{\partial \log P_g} + \frac{\partial \varepsilon_{gf}}{\partial \log P_g} \right) \\ &= -\frac{(\sigma - \varepsilon_{gf})(\sigma - 1)}{\varepsilon_{gf}(\varepsilon_{gf} - 1)} \left(\frac{\partial \log p_{gf}}{\partial \log P_g} - 1 \right) \\ &= -\rho_{gf} \left(\frac{\partial \log p_{gf}}{\partial \log P_g} - 1 \right) \\ &= \frac{\rho_{gf}}{1 + \rho_{gf}} = 1 - \frac{1}{1 + \rho_{gf}} \end{aligned}$$

where the third row uses the expression derived above, $\frac{\partial \varepsilon_{gf}}{\partial \log p_{gf}} = -\frac{\partial \varepsilon_{gf}}{\partial \log P_g} = (\sigma - \varepsilon_{gf})(\sigma - 1)$; and the fourth row uses the definition of ρ_{gf}.

This implies that

$$d\log p_{gf} = \beta^p_{gf} d\log c_{gf} + (1 - \beta^p_{gf}) d\log P_g$$

where $\beta^p_{gf} \equiv 1/(1 + \rho_{gf})$.

Thus,

$$\begin{aligned} d\log P_g &= \textstyle\sum_{f \in \mathcal{F}_g} e_{gf} d\log p_{gf} \\ &= \textstyle\sum_{f \in \mathcal{F}_g} S^E_{gf} \beta^p_{gf} d\log c_{gf} + \sum_{f \in \mathcal{F}_g} e_{gf} (1 - \beta^p_{gf}) d\log P_g \\ &= \textstyle\sum_{f \in \mathcal{F}_g} \omega_{gf} d\log c_{gf} \end{aligned}$$

which implies that

$$d\log P_g = d\log c_g \equiv \sum_{f \in \mathcal{F}_g} \omega_{gf} d\log c_{gf} \quad \text{and} \quad \omega_{gf} \equiv \frac{e_{gf} \beta^p_{gf}}{\sum_{f' \in \mathcal{F}_g} e_{gf'} \beta^p_{gf'}}. \tag{A.16}$$

We also have that

$$\begin{aligned} d\log\mu_{gf} &= d\log p_{gf} - d\log c_{gf} \\ &= (\beta^p_{gf} - 1)\left(d\log c_{gf} - d\log P_g\right) \end{aligned}$$

Thus,

$$d\log\mu_{gf} = -\beta^{\mu}_{gf}\left(d\log c_{gf} - d\log c_g\right) \tag{A.17}$$

where we use the fact that $\beta^{\mu}_{gf} = (1 - \beta^p_{gf})$.

We can then substitute this expression into the expression for the change in the firm's sales:

$$\begin{aligned} d\log q_{gf} &= -\sigma d\log p_{gf} + (\sigma - \eta) d\log P_g + d\log Q \\ &= \left(-\sigma\tfrac{1}{1+\rho_{gf}}\right) d\log c_{fg} - \sigma\left(1 - \tfrac{1}{1+\rho_{gf}}\right) d\log P_g + (\sigma - \eta) d\log P_g + d\log Q \\ &= \left(-\sigma\tfrac{1}{1+\rho_{gf}}\right)\left(d\log c_{gf} - d\log P_g\right) - \eta d\log P_g + d\log Q \end{aligned}$$

Thus,

$$d\log q_{fg} = -\beta^q_{gf}(d\log c_{gf} - d\log c_g) - \eta d\log c_g + d\log Q \tag{A.18}$$

where $\beta^q_{gf} = \sigma\beta^p_{gf}$.

Note that we can write

$$\omega_{fg} \equiv \frac{e_{gf}\beta^p_{gf}}{\sum_{f'\in\mathcal{F}_g} e_{gf'}\beta^p_{gf'}} = \frac{M_{gf}\mu_{gf}\beta^q_{gf}}{\sum_{f'\in\mathcal{F}_g} M_{gf'}\mu_{gf'}\beta^q_{gf'}} \tag{A.19}$$

where we use $e_{gf} = E_{gf}/E_g = \mu_{gf}M_{gf}/E_g$.

Domestic Firms. For all $g \in \mathcal{G}^D$, (A.3) implies that $d\log c_{gf} = d\log w$ and, thus, $d\log P_g = d\log p_{gf} = d\log w$. Using (A.18), we have that

$$d\log q_{gf} = d\log q^D \equiv -\eta d\log w + d\log Q \quad \text{for all} \quad g \in \mathcal{G}^D. \tag{A.20}$$

Importer Firms. For all $g \in \mathcal{G}^M$, (A.5) implies that

$$d\log c_{gf} = \sum_o m_{ogf} d\log p_{og} \tag{A.21}$$

with $m_{ogf} \equiv p_{og}q_{ogf}/M_{gf}$ defined as the share of firm f's imports of good g from origin o, and

$$d\log p_{og} = d\log(1 + \tau_{og}) + d\log p^W_{og}.$$

Equation (A.6) implies that

$$d\log q_{ogf} = -\theta(d\log p_{og} - d\log c_{gf}) + d\log q_{gf}. \tag{A.22}$$

Equation (A.18) implies that

$$d\log q_{gf} = -\beta^q_{gf}(d\log c_{gf} - d\log c_g) - \eta d\log c_g + d\log Q \tag{A.23}$$

with $d\log c_g \equiv \sum_{f\in\mathcal{F}_g} \omega_{gf} d\log c_{gf}$.

A.3.2 Aggregate Responses

The price index is given by

$$d\log P = (1-e^M)d\log w + e^M d\log c^M \tag{A.24}$$

where $e^M \equiv E^M/E$, $E^M \equiv \sum_{g\in\mathcal{G}^M} E_g$, $E_g \equiv M_g\bar{\mu}^M_g$, $\bar{\mu}^M_g \equiv \sum_{f\in\mathcal{F}_g} M_{gf}\mu_{gf}/M_g$, $M_g \equiv \sum_{f\in\mathcal{F}_g} M_{gf}$, and

$$d\log c^M \equiv \sum_{g\in\mathcal{G}^M} \frac{M_g\bar{\mu}^M_g}{\sum_{g'\in\mathcal{G}^M} M_{g'}\bar{\mu}^M_{g'}} d\log c_g. \tag{A.25}$$

We now solve for aggregate variable in terms of the change in the economy's aggregate real spending, $C = E/P$. Note that

$$\begin{aligned} d\log Q &= \eta d\log P + d\log C \\ &= \eta(1-e^M)d\log w + \eta e^M d\log c^M + d\log C \end{aligned}$$

Equations (A.20) and (A.23) imply that

$$d\log q^D = -\eta e^M(d\log w - d\log c^M) + d\log C \tag{A.26}$$

$$d\log q_{gf} = -\beta^q_{gf}(d\log c_{gf} - d\log c_g) - \eta(d\log c_g - d\log c^M) + \eta(1-e^M)\left(d\log w - d\log c^M\right) + d\log C \tag{A.27}$$

We now use the labor market clearing condition to solve for $d\log w$ as a function of $d\log C$. From the labor market clearing condition in (A.12),

$$0 = \sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} L_{gf} d\log q_{gf} = d\log q^D \ ,$$

which combined with (A.26) implies that

$$d\log w = d\log c^M + \frac{1}{\eta e^M} d\log C \tag{A.28}$$

Also, we can plug (A.28) into (A.27) to get that

$$d\log q_{gf} = -\beta^q_{gf}(d\log c_{gf} - d\log c_g) - \eta(d\log c_g - d\log c^M) + \frac{1}{e^M} d\log C. \tag{A.29}$$

A.3.3 Aggregate Welfare Effect

Price index. Let us write the change in the price index as

$$d\log P = \sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{p_{gf}q_{gf}}{E}(d\log\mu_{gf}+d\log c_{gf}) \tag{A.30}$$

Profits. For every firm, we can write:

$$d\Pi_{gf} = q_{gf}(dp_{gf}-dc_{gf})+(p_{gf}-c_{gf})dq_{gf},$$

which implies that

$$d\Pi_{gf} = p_{gf}q_{gf}\left(d\log\mu_{gf}+(1-1/\mu_{gf})(d\log c_{gf}+d\log q_{gf})\right). \tag{A.31}$$

For importer firms, using $p_{gf}q_{gf}=\mu_{gf}C_{gf}$, (A.31) implies that

$$d\Pi^M \equiv \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}d\Pi_{gf} = \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}C_{gf}\left(\mu_{gf}d\log\mu_{gf}+(\mu_{gf}-1)(d\log c_{gf}+d\log q_{gf})\right). \tag{A.32}$$

For domestic firms, $d\log\mu_{gf}=d\log q_{gf}=0$ for all $g\in\mathcal{G}^D$, so (A.31) implies that

$$d\Pi^D = \sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}d\Pi_{fg} = \Pi^D d\log w \tag{A.33}$$

with $\Pi^D\equiv\sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\Pi_{gf}$.

For exporter firms, profits do not change as world prices and endowments remain constant:

$$d\Pi^X = \sum_{g\in\mathcal{G}^X}\sum_{f\in\mathcal{F}_g}d\Pi_{gf} = 0. \tag{A.34}$$

Tariff revenue. The expression for tariff revenue in (A.11) implies that

$$dT = \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{o}\left(\tau_{og}p^W_{og}dq_{ogf}+q_{ogf}d(\tau_{og}p^W_{og})\right). \tag{A.35}$$

Aggregate Real Spending. By definition, the change in aggregate real spending is:

$$dC \equiv Ed\log C = dE - Ed\log P = dw\bar{L}+d\Pi^M+d\Pi^D+d\Pi^X+dT-Ed\log P.$$

We now use the expressions above to substitute for each term:

$$\begin{aligned} dC &= d\log w\left(\textstyle\sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} c_{gf}q_{gf}\right) \\ &+ \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} q_{gf}p_{gf}\left(d\log\mu_{gf} + (1-1/\mu_{gf})(d\log c_{gf} + d\log q_{gf})\right) \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o \left(\tau_{og}p_{og}^W dq_{ogf} + q_{ogf}d(\tau_{og}p_{og}^W)\right) \\ &- \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(p_{gf}q_{gf})\left(d\log\mu_{gf} + d\log c_{gf}\right) \end{aligned}$$

where we use expressions (A.12) for $\bar{L}$, (A.31) for $d\Pi^M$ and $d\Pi^D$, (A.34) for $d\Pi^X$, (A.35) for dT, and (A.30) for dP.

Manipulating this expression, we get that

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}(\mu_{gf}-1)d\log q_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o \tau_{og}p_{og}^W q_{ogf}d\log q_{ogf} \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}d\log c_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o q_{ogf}d(\tau_{og}p_{og}^W) \end{aligned}$$

Using the expression in (A.21) to substitute for $d\log c_{gf}$ of importer firms in any $g\in\mathcal{G}^M$, the expression above becomes

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}(\mu_{gf}-1)d\log q_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o \tau_{og}p_{og}^W q_{ogf}d\log q_{ogf} \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o q_{ogf}\left(d(\tau_{og}p_{og}^W) - dp_{og}\right) \end{aligned}$$

Since $dp_{og} = d((1+\tau_{og})p_{og}^W) = dp_{og}^W + d(\tau_{og}p_{og}^W)$, this expression is equivalent to

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}(\mu_{gf}-1)d\log q_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o \tau_{og}p_{og}^W q_{ogf}d\log q_{ogf} \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o p_{og}^W q_{ogf}d\log p_{og}^W \end{aligned}$$

Note that, by definition, $\Pi_{gf} = q_{gf}(p_{gf}-c_{gf}) = q_{gf}c_{gf}(\mu_{gf}-1)$, $T_{ogf} = \tau_{og}p_{og}^W q_{ogf}$, and $v_{ogf} \equiv p_{og}^W q_{ogf}$. Thus,

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\Pi_{gf}d\log q_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}d\log q_{ogf} \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf}d\log p_{og}^W \end{aligned} \tag{A.36}$$

We now obtain another expression for real spending in terms of shocks. By plugging $d\log q_{gf} =$

0 for all $g \in \mathcal{G}^D$ and $d \log q_{ogf}$ in (A.22) into (A.36):

$$\begin{aligned} dC &= \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})d\log q_{gf} \\ &- \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}\theta(d\log p_{og}-d\log c_{gf}) \\ &- \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf}d\log p^W_{og} \end{aligned} \tag{A.37}$$

with $T_{gf} \equiv \sum_o T_{ogf}$.

Using (A.29), this expression becomes

$$\begin{aligned} dC &= \tfrac{\Pi^M+T}{E^M}Ed\log C \\ &- \sum_{g\in\mathcal{G}^M}(\Pi_g+T_g)\eta(d\log c_g-d\log c^M) \\ &- \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})\beta^q_{gf}(d\log c_{gf}-d\log c_g) \\ &- \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}\theta(d\log p_{og}-d\log c_{gf}) \\ &- \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf}d\log p^W_{og} \end{aligned}$$

with $\Pi_g = \sum_{f\in\mathcal{F}_g}\Pi_{gf}$, $T_g = \sum_{f\in\mathcal{F}_g}T_{gf}$, $\Pi^M \equiv \sum_{g\in\mathcal{G}^M}\Pi_g$ and $T = \sum_{g\in\mathcal{G}^M}T_g$.

Note that

$$\left(1-\frac{\Pi^M+T}{E^M}\right) = \left(E^M-\Pi^M-T\right)\frac{1}{E^M} = \frac{V}{E^M} = \frac{1}{E^M/M}\frac{1}{M/V}$$

where we use the fact that $\Pi^M = E^M - M$, $M \equiv \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o p_{og}q_{ogf}$, $V \equiv \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o p^W_{og}q_{ogf}$, and $M = V + T$.

Thus,

$$\begin{aligned} dC = &-\chi \sum_{g\in\mathcal{G}^M}(\Pi_g+T_g)\eta(d\log c_g-d\log c^M) \\ &-\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})\beta^q_{gf}(d\log c_{gf}-d\log c_g) \\ &-\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}\theta(d\log p_{og}-d\log c_{gf}) \\ &-\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf}d\log p^W_{og} \end{aligned} \tag{A.38}$$

where $\chi \equiv \bar{\mu}^M(1+\bar{\tau}^M)$, with $\bar{\mu}^M \equiv E^M/M = \sum_{g\in\mathcal{G}^M}M_g\bar{\mu}_g/M$ and $\bar{\tau}^M \equiv T/V$.

We now split this equation into three parts. The first is the component associated with markup distortions (MD):

$$\begin{aligned} dC^{\text{MD}} = &-\chi \sum_{g\in\mathcal{G}^M}\Pi_g\eta(d\log c_g-d\log c^M) \\ &-\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\Pi_{gf}\beta^q_{gf}(d\log c_{gf}-d\log c_g). \end{aligned} \tag{A.39}$$

The second is the component associated with distortions created by the initial tariffs (TD):

$$\begin{aligned} dC^{\text{TD}} = &-\chi \sum_{g\in\mathcal{G}^M}T_g\eta(d\log c_g-d\log c^M) \\ &-\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}T_{gf}\beta^q_{gf}(d\log c_{gf}-d\log c_g) \\ &-\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}\theta(d\log p_{og}-d\log c_{gf}) \end{aligned} \tag{A.40}$$

The last term is the change in terms of trade associated with the change in world prices:

$$dC^{\text{ToT}} = - \chi \sum_{g\in\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} \sum_o v_{ogf} d\log p^W_{og} . \tag{A.41}$$

Note that, by construction,

$$dC = dC^{\text{MD}} + dC^{\text{TW}} + dC^{\text{ToT}}.$$

We now re-write the markup in terms of the markup dispersion in the economy. Given the definitions in (A.19) and (A.25), $\sum_{g\in\mathcal{G}^M} M_g \mu_g^M (d\log c_g - d\log c^M) = \sum_{f\in\mathcal{F}_g} M_{gf}\mu_{gf}\beta^q_{gf}(d\log c_{gf} - d\log c_g) = 0$. Thus, (A.39) becomes

$$\begin{aligned} dC^{\text{MD}} &= \chi \sum_{g\in\mathcal{G}^M} M_g \eta (d\log c_g - d\log c^M) \\ &+ \chi \sum_{g\in\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} M_{gf}\beta^q_{gf}(d\log c_{gf} - d\log c_g). \end{aligned}$$

Substituting for the definitions of $d\log c^M$ and $d\log c_g$, we get that

$$\begin{aligned} dC^{\text{MD}} &= \chi \left[\sum_{g\in\mathcal{G}^M} M_g \eta d\log c_g - \sum_{g\in\mathcal{G}^M} \frac{M_g \mu_g^M}{\sum_{g'\in\mathcal{G}^M} M_{g'}\mu^M_{g'} / \sum_{g'\in\mathcal{G}^M} M_{g'}} \eta d\log c_g \right] \\ &+ \chi \sum_{g\in\mathcal{G}^M} \left[\sum_{f\in\mathcal{F}_g} M_{gf}\beta^q_{gf} d\log c_{gf} - \sum_{f\in\mathcal{F}_g} \frac{M_{gf}\beta^q_{gf}\mu_{gf}}{\sum_{f'\in\mathcal{F}_g} M_{gf'}\beta^q_{gf'}\mu_{gf'} / \sum_{f'\in\mathcal{F}_g} M_{gf'}\beta^q_{gf'}} d\log c_{gf} \right]. \end{aligned}$$

By defining $\bar{\mu}^q_g \equiv \sum_{f\in\mathcal{F}_g} M_{gf}\beta^q_{gf}\mu_{gf} / \sum_{f\in\mathcal{F}_g} M_{gf}\beta^q_{gf}$, the expression above becomes

$$\begin{aligned} dC^{\text{MD}} &= \chi \sum_{g\in\mathcal{G}^M} \left(1 - \frac{\bar{\mu}^M_g}{\bar{\mu}^M}\right) M_g \eta d\log c_g \\ &+ \chi \sum_{g\in\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} \left(1 - \frac{\mu_{gf}}{\bar{\mu}^q_g}\right) M_{gf}\beta^q_{gf} d\log c_{gf}. \end{aligned}$$

Thus,

$$\frac{dC^{\text{MD}}}{M} = \chi \sum_{g\in\mathcal{G}^M} m_g \left[\left(1 - \frac{\bar{\mu}^M_g}{\bar{\mu}^M}\right) \eta d\log c_g + \sum_{f\in\mathcal{F}_g} m_{gf} \left(1 - \frac{\mu_{gf}}{\bar{\mu}^q_g}\right) \beta^q_{gf} d\log c_{gf} \right] \tag{A.42}$$

This implies (6) when we note that $\sum_{g\in\mathcal{G}^M} m_g \left(1 - \frac{\bar{\mu}^M_g}{\bar{\mu}^M}\right) = \sum_{f\in\mathcal{F}_g} m_{gf} \left(1 - \frac{\mu_{gf}}{\bar{\mu}^q_g}\right) \beta^q_{gf} = 0$.

A.3.4 Distributional Welfare Effect

From (A.32),

$$d\Pi^M = \sum_{g\in\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} \left(E_{gf} d\log \mu_{gf} + \Pi_{gf} \left(d\log c_{gf} + d\log q_{gf} \right) \right)$$

which, given the expression for $d\log\mu_{gf}$ in (3) and the definition of dC^{MD} in (A.39), is equivalent to

$$\begin{aligned} d\Pi^M &= -\textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} E_{gf}\beta^{\mu}_{gf}(d\log c_{gf} - d\log c_g) \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} \Pi_{gf} d\log c_{gf} \\ &+ dC^{\text{MD}} \end{aligned}$$

The combination of (A.24) and (A.28) implies that $d\log P = d\log c^M + \frac{e^D}{\eta e^M} d\log C$. Thus, $dC^M \equiv d\Pi^M - \Pi^M d\log P$ is given by

$$\begin{aligned} dC^M &= -\textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} E_{gf}\beta^{\mu}_{gf}(d\log c_{gf} - d\log c_g) \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} \Pi_{gf}\left(d\log c_{gf} - d\log c^M\right) \\ &\quad \left(dC^{\text{MD}} - \tfrac{\Pi^M}{E^M}\tfrac{e^D}{\eta} dC\right) \end{aligned}$$

Since $\beta^{\mu}_{gf} = 1 - \beta^{q}_{gf}/\sigma$ from (4) and, by definition, $E_{gf} = \mu_{gf} M_{gf}$ and $\Pi_{gf} = (\mu_{gf} - 1) M_{gf}$, this expression implies that

$$\begin{aligned} dC^M &= dC^{\text{MD}} - \tfrac{\Pi^M}{E^M}\tfrac{e^D}{\eta} dC \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} M_{gf}\left(d\log c_{gf} - d\log c^M\right) \end{aligned}$$

The definitions of $d\log c^M$ implies that

$$\begin{aligned} dC^M &= dC^{\text{MD}} - \tfrac{\Pi^M}{E^M}\tfrac{e^D}{\eta} dC \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} M_{gf} d\log c_{gf} \\ &+ M\textstyle\sum_{g\in\mathcal{G}^M} \frac{M_g\bar{\mu}^M_g}{\sum_{g\in\mathcal{G}^M} M_g\bar{\mu}^M_g} \sum_{f\in\mathcal{F}_g} \frac{M_{gf}\mu_{gf}\beta_{gf}}{\sum_{f\in\mathcal{F}_g} M_{gf}\mu_{gf}\beta_{gf}} d\log c_{gf} \end{aligned}$$

which, given the definitions of m^q_{gf} and $\bar{\mu}^q_{gf}$, is equivalent to

$$\begin{aligned} \tfrac{dC^M}{M} &= \left(dC^{\text{MD}} - \tfrac{\Pi^M}{E^M}\tfrac{e^D}{\eta} dC\right) \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} m_g \left(m^q_{gf}\frac{\bar{\mu}^M_g}{\bar{\mu}^M}\frac{\mu_{gf}}{\bar{\mu}^q_g} - m_{gf}\right) d\log c_{gf} \end{aligned} \tag{A.43}$$

Given that $\frac{\Pi^M}{E^M} = \frac{(\bar{\mu}^M - 1)M}{\bar{\mu}^M M}$,

$$\begin{aligned} \tfrac{dC^M}{M} &= \left(\tfrac{dC^{\text{MD}}}{M} - \tfrac{(\bar{\mu}^M - 1)(1 - e^M)}{\eta\bar{\mu}^M}\tfrac{dC}{M}\right) \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} m_g \left(m^q_{gf}\frac{\bar{\mu}^M_g}{\bar{\mu}^M}\frac{\mu_{gf}}{\bar{\mu}^q_g} - m_{gf}\right) d\log c_{gf} \end{aligned}$$

In the special case that $dC = dC^{\text{MD}}$,

$$\begin{aligned} \tfrac{dC^M}{M} &= \left(1 - \tfrac{(\bar{\mu}^M - 1)(1 - e^M)}{\eta\bar{\mu}^M}\right)\tfrac{dC}{M} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} m_g \left(m^q_{gf}\frac{\bar{\mu}^M_g}{\bar{\mu}^M}\frac{\mu_{gf}}{\bar{\mu}^q_{gf}} - m_{gf}\right) d\log c_{gf}. \end{aligned}$$

This immediately implies (8).

For completeness, note that

$$\begin{aligned} d\log w\bar{L}/P &= d\log w - d\log P \\ &= e^M(d\log w - d\log c^M) \\ &= \tfrac{1}{\eta} d\log C. \end{aligned}$$

which implies that $dC^L \equiv dw\bar{L} - w\bar{L}d\log P$ is given by

$$dC^L = \frac{wL}{E}\frac{1}{\eta}dC \tag{A.44}$$

Note also that (A.33) and $d\log\mu_{gf} = d\log q_{gf} = 0$ implies that $d\log\Pi^D = d\log w$. Thus, $dC^D \equiv d\Pi^D - \Pi^D d\log P$ is given by

$$dC^D = \frac{\Pi^D}{E}\frac{1}{\eta}dC \tag{A.45}$$

A.3.5 Measurement

Aggregate Welfare Effect. For any given set of shocks $d\log p_{og}$ and $d\log p^W_{og}$, we can compute dC in (A.38) with the following variables: (i) firm-level custom data, $\{M_{ogf}, T_{ogf}\}$; (ii) the elasticity parameters $\{\eta, \theta\}$; and (iii) the elasticity function, $\beta^q(m)$.

First, note that $\sigma = \beta^q(0)$ and $\beta^q_{gf} = \beta^q(m_{gf})$, with $m_{gf} = M_{gf}/M_g$, $M_{gf} = \sum_o M_{ogf}$ and $M_g = \sum_{f\in\mathcal{F}_g} M_{gf}$. We can then use the mapping in (A.14) to compute μ_{gf} as a function of β^q_{gf} and σ. This allows us to compute firm-level variables: profits, $\Pi_{gf} = (\mu_{gf}-1)M_{gf}$, domestic expenditure, $E_{gf} = \mu_{gf}M_{gf}$, and taxes, $T_{gf} = \sum_o T_{ogf}$.

We can then compute all aggregate variables: $\Pi_g = \sum_{f\in\mathcal{F}_g}\Pi_{gf}$, $T_g = \sum_{f\in\mathcal{F}_g} T_{gf}$, $E_g \equiv \sum_{f\in\mathcal{F}_g} E_{gf}$, $M \equiv \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o M_{ogf}$, $E^M \equiv \sum_{g\in\mathcal{G}^M} E_g$, $T = \sum_{g\in\mathcal{G}^M} T_g$, $V = M - T$, $\bar{\mu}^M \equiv E^M/M$ and $\bar{\tau}^M \equiv T/M^W$.

Finally, we can compute $d\log c_{gf}$ using (A.21) with $m_{ogf} = M_{ogf}/M_{gf}$, $d\log c_g$ using (A.16) with $\omega_{gf} \equiv \mu_{gf}m^q_{gf}/\sum_{f'\in\mathcal{F}_g}\mu_{gf'}m^q_{gf'}$ and $m^q_{gf} \equiv M_{gf}\beta_{gf}/\sum_{f'\in\mathcal{F}_g} M_{gf'}\beta_{gf'}$, and $d\log c^M$ using (A.25).

Relative Welfare Effect. For any given set of shocks $d\log p^M_{og}$ and $d\log p^W_{og}$, we can compute dC^M in (A.43) with the following variables: (i) firm-level custom data, $\{M_{ogf}, T_{ogf}\}$; (ii) the elasticity parameters $\{\eta, \theta\}$; (iii) the elasticity function, $\beta^q(m)$; and (iv) the import-to-expenditure ratio, M/E.

To see this, note that dC^M in (A.43) depends on the same variables as dC in (A.38) in addition to $e^M = E^M/E$, which we can compute as $e^M = \bar{\mu}^M M/E$.

B Extensions

B.1 Large Economy with Integrated Labor Market

B.1.1 Environment

We maintain the same structure of preferences and production of the baseline model, but we now consider two extensions.

Foreign Offer Curve. We assume that firms in the country face log-linear foreign demand and supply curves, similar to the specifications in Broda et al. (2008) and Fajgelbaum et al. (2020). Given a price of p_{gf}, the demand for exported good $g \in \mathcal{G}^X$ of firm f in destination o is given by

$$q_{ogf} = a^W_{ogf}(p_{ogf})^{-\sigma^W} \tag{B.1}$$

where a^W_{gf} is a demand shifter, and $\sigma^W > 0$ is the export demand elasticity.

We also assume that, given imports of q^W_{ogf}, the inverse supply curve faced by good g of country o is

$$p^W_{ogf} = a^W_{ogf}(q^W_{ogf})^{\omega^W} \tag{B.2}$$

where a^W_{ogf} is a demand shifter, and $\omega^W > 0$ is the import supply elasticity.

Market Clearing. We assume that exporter and importer firms use the same type of labor. Thus, the labor market clearing condition is

$$\bar{L} = \sum_{g \in \mathcal{G}^D \cup \mathcal{G}^X} \sum_{f \in \mathcal{F}_g} L_{gf}, \tag{B.3}$$

with $\bar{L} \equiv \bar{L}^D + \sum_{g \in \mathcal{G}^X} \sum_{f \in \mathcal{F}_g} \bar{L}^X_{gf}$.

Market Structure. Domestic and Importer firms behave as in the baseline model. In addition, we assume that exporters also make pricing decisions given the their demand in each destination, as specified in (B.1). For simplicity, we maintain the assumption that all firms take as given the foreign import prices and the domestic wage rate.

Equilibrium. The equilibrium is similar to that of the baseline model, with three modifications.

First, the world price of imported products must satisfy the foreign supply curve in (B.2)

Second, given their marginal cost $c_{gf} = w$, exporter firm f solve the following problem:

$$\Pi_{gf} \equiv \sum_o \max_{p_{ogf}, q_{ogf}} (p_{ogf} - c_{gf}) q_{ogf} \quad \text{subject to } q_{ogf} \text{ given by (B.1)} \tag{B.4}$$

which yields

$$p_{ogf} = \frac{\sigma^W}{\sigma^W - 1} w, \quad E_{gf} = (w)^{1-\sigma^W} \delta_{gf}^W, \quad wL_{gf} = \frac{1}{\sigma^W} E_{gf}, \quad \Pi_{gf} = \left(1 - \frac{1}{\sigma^W}\right) E_{gf}, \tag{B.5}$$

with $\delta_{gf}^W \equiv (\frac{\sigma^W}{\sigma^W - 1})^{1-\sigma^W} \sum_o a_{ogf}^W$.

Third, the labor market clearing condition is given by (B.3).

B.1.2 Firm-level Responses

Expressions (A.21)–(A.23) remain valid given changes in import prices, import tariffs, and aggregate demand shifter. We now solve for the endogenous changes in import prices in order to write quantity changes in terms of changes in import tariffs and aggregate shifter.

We start by re-writing the quantity change for importer firms as

$$d \log q_{ogf}^M = -\theta (d \log p_{ogf}^W - d \log p_{gf}^W) - \theta (d \log(1 + \tau_{og}) - d \log c_{gf}^\tau) + d \log q_{gf} \tag{B.6}$$

and

$$d \log q_{gf} = d \log q_{gf}^W + d \log q_{gf}^\tau + d \log Q \tag{B.7}$$

where

$$d \log q_{gf}^\tau = -\beta_{gf}^q (d \log c_{gf} - d \log c_g^\tau) - \eta d \log c_g^\tau$$
$$d \log q_{gf}^W = -\beta_{gf}^q (d \log p_{gf}^W - d \log p_g^W) - \eta d \log p_g^W$$

with $d \log p_{gf}^W \equiv \sum_o m_{ogf} d \log p_{ogf}^W$, $d \log c_{gf} \equiv \sum_o m_{ogf} d \log(1 + \tau_{og})$, $d \log p_g^W \equiv \sum_{f \in \mathcal{F}_g} \omega_{gf} d \log p_{gf}^W$, and $d \log c_g^\tau \equiv \sum_{f \in \mathcal{F}_g} \omega_{gf} d \log c_{gf}$.

The combination of the import supply curve in (B.2) and the import change in (B.6) implies that

$$d \log p_{ogf}^W = -\omega^W \theta (d \log p_{ogf}^W - d \log p_{gf}^W) - \omega^W \theta (d \log(1 + \tau_{og}) - d \log c_{gf}^M) + \omega^W d \log q_{gf},$$

and, by aggregating across origins for the same firm with m_{ogf}, $d \log p_{gf}^W = \omega^W d \log q_{gf}$. Thus,

$$d \log p_{ogf}^W - d \log p_{gf}^W = -\frac{\omega^W \theta}{1 + \omega^W \theta} (d \log(1 + \tau_{og}) - d \log c_{gf}), \tag{B.8}$$

$$d \log q_{ogf} = -\frac{\theta}{1 + \omega^W \theta} (d \log(1 + \tau_{og}) - d \log c_{gf}) + d \log q_{gf}. \tag{B.9}$$

Using (B.7),

$$\begin{aligned} d\log p_{gf}^W &= \omega^W d\log q_{gf} \\ &= \omega^W(-\beta_{gf}^q d\log p_{gf}^W + (\beta_{gf}^q - \eta)d\log p_g^W) + \omega^W(d\log q_{gf}^\tau + d\log Q) \\ &= \omega^W((\beta_{gf}^q - \eta)d\log p_g^W + d\log q_{gf}^\tau + d\log Q)/(1+\omega^W\beta_{gf}^q) \end{aligned}$$

which, aggregating across firms for the same good with ω_{gf},

$$\begin{aligned} d\log p_g^W &= (\textstyle\sum_f \omega_{gf}\frac{\omega^W(\beta_{gf}^q-\eta)}{1+\omega^W\beta_{gf}^q})d\log p_g^W + \omega^W\sum_f \frac{\omega_{gf}}{1+\omega^W\beta_{gf}^q}d\log q_{gf}^\tau + \omega^W\sum_f\frac{\omega_{gf}}{1+\omega^W\beta_{gf}^q}d\log Q \\ &= \omega^\tau(\textstyle\sum_{f\in\mathcal{F}_g}\omega_{gf}^W d\log q_{gf}^\tau + d\log Q) \\ &= \omega^\tau\left(-d\log p_g^\tau + d\log Q\right) \end{aligned}$$

with $\omega_{gf}^W \equiv \frac{\omega_{gf}/(1+\omega^W\beta_{gf}^q)}{\sum_{f'\in\mathcal{F}_g}\omega_{gf'}/(1+\omega^W\beta_{gf'}^q)}$, $\omega^\tau \equiv \frac{\omega^W}{1+\omega^W\eta}$, and

$$d\log p_g^\tau \equiv \sum_{f\in\mathcal{F}_g}\omega_{gf}^W\beta_{gf}^q(d\log c_{gf} - d\log c_g^\tau) + \eta d\log c_g^\tau.$$

Using the expressions above for $d\log p_{gf}^W$ and $d\log p_g^W$, (B.7) implies that

$$d\log q_{gf} = \frac{-\beta_{gf}^q}{1+\omega^W\beta_{gf}^q}\left(d\log c_{gf} - d\log c_g\right) - \frac{\eta}{1+\omega^W\beta_{gf}^q}d\log c_g + \frac{1}{1+\omega^W\eta}d\log Q. \tag{B.10}$$

$$d\log P_g = d\log c_g^\tau + d\log p_g^W = d\log c_g + \omega^\tau d\log Q \tag{B.11}$$

with $d\log c_g \equiv d\log c_g^\tau - \omega^\tau d\log p_g^\tau$.

B.1.3 Aggregate Responses

Using (B.11), the change in the import price index is

$$d\log P^M = \sum_{g\in\mathcal{G}^M} e_g^M d\log P_g = d\log c^M + \omega^\tau d\log Q$$

with $d\log c^M \equiv \sum_{g\in\mathcal{G}^M} e_g^M d\log c_g$ and, as in the baseline model, $e_g^M \equiv \bar{\mu}_g^M M_g / \sum_{g'\in\mathcal{G}^M}\bar{\mu}_{g'}^M M_{g'}$. Thus,

$$\begin{aligned} d\log Q &= \eta d\log P + d\log C \\ &= \eta(1-e^M)d\log w + \eta e^M d\log c^M + \eta e^M\omega^\tau d\log Q + d\log C \\ &= \frac{\eta(1-e^M)d\log w + \eta e^M d\log c^M + d\log C}{1-\eta e^M\omega^\tau} \end{aligned}$$

We now solve for the wage change using the labor market clearing condition in (B.3), quantity

changes for exporters in (B.5) and domestic firms in (A.20), and the aggregate shifter above:

$$\begin{aligned} 0 &= \ell^X d\log q^X + \ell^D d\log q^D \\ 0 &= -\ell^X \sigma^W d\log w + \ell^D(-\eta d\log w + d\log Q) \\ d\log w &= \beta^w(d\log c^M + d\log C/\eta e^M) \end{aligned}$$

where $W^D \equiv \sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} w\ell_{gf}$, $\ell^D \equiv W^D/wL$, $\ell^X = 1-\ell^D$, and $\beta^w \equiv \ell^D\eta e^M/((1-\eta e^M\omega^\tau)(\ell^X\sigma^W + \ell^D\eta) - \ell^D\eta(1-e^M))$.

From quantity changes for exporters in (B.5), domestic firms in (A.20), and importer firms in (B.7),

$$d\log q^X = -\sigma^W\beta^w(d\log c^M + \frac{1}{\eta e^M}d\log C) \tag{B.12}$$

$$d\log q^D = \beta^D(\eta e^M d\log c^M + d\log C) \tag{B.13}$$

$$\begin{aligned} \log q_{gf} = &- \frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \\ &- \frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\ &- \left(\frac{1/e^M}{1+\omega^W\beta^q_{gf}} - \beta^M\right)\eta e^M d\log c^M \\ &+ \beta^M d\log C \end{aligned} \tag{B.14}$$

where

$$\beta^D \equiv \frac{1-(1-\eta\omega^\tau)\beta^w}{1-\eta e^M\omega^\tau} \quad \text{and} \quad \beta^M \equiv \frac{1+\beta^w e^D/e^M}{1+\omega^W\eta e^D}.$$

B.1.4 Aggregate Welfare

The same steps in Section A.3.3 implies that

$$\begin{aligned} dC &= \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}(\mu_{gf}-1)d\log q_{gf} \\ &+ \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}d\log q_{ogf} \\ &+ \sum_{g\in\mathcal{G}^X}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}\mu_{gf}d\log p^W_{ogf} \\ &- \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf}\log p^W_{ogf} \end{aligned}$$

Note that, because of the log-linear foreign demand, the price and allocation terms for exporters cancel out:

$$\begin{aligned} (\mu_{gf}-1)d\log q_{gf} + \mu_{gf}d\log p^W_{ogf} &= \left(-(\mu_{gf}-1)\sigma^W + \mu_{gf}\right)d\log c_{gf} \\ &= \left(-(\sigma^W-\sigma^W+1)\sigma^W + \sigma^W\right)\tfrac{1}{\sigma^W-1}d\log c_{gf} \\ &= 0 \end{aligned}$$

Thus,

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\Pi_{gf}d\log q_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}d\log q_{ogf} \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf}d\log p^W_{ogf} \end{aligned}$$

Using the foreign supply curve in (B.2), the expression for $d\log q_{ogf}$ in (B.9) and the fact that $d\log q_{gf} = d\log q^D$ for all $g\in\mathcal{G}^D$, this expression becomes

$$\begin{aligned} dC &= \Pi^D d\log q^D \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(\Pi_{gf}+T_{ogf}+\omega^W v_{ogf}\right)d\log q_{gf} \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o\left(T_{ogf}+\omega^W v_{ogf}\right)\frac{\theta}{1+\omega^W\theta}(d\log(1+\tau_{og})-d\log c_{gf}) \end{aligned}$$

with $\Pi^D \equiv \sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\Pi_{gf} = E - E^M - W^D$.

Using expressions (B.13) and (B.14),

$$\begin{aligned} dC = \; & -\chi \quad \left(\left(\chi^{-1}-1\right)\bar{\mu}^M M + \chi\textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{\Pi_{gf}+T_{gf}+\omega^W v_{gf}}{1+\omega^W\beta^q_{gf}}\right)\eta d\log c^M \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(\Pi_{gf}+T_{gf}+\omega^W v_{gf}\right)\frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(\Pi_{gf}+T_{gf}+\omega^W v_{gf}\right)\frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o\left(T_{ogf}+\omega^W v_{gf}\right)\frac{\theta}{1+\omega^W\theta}(d\log(1+\tau_{og})-d\log c_{gf}) \end{aligned} \tag{B.15}$$

where

$$\chi^{-1} \equiv 1 - \frac{\beta^D\Pi^D + \beta^M\left(\Pi^M + T + \omega^W V\right)}{E}$$

Again, we split this equation into three parts. The first is the component associated with markup distortions (MD):

$$\begin{aligned} dC^{\text{MD}} = \; & +\chi \quad \left(\left(\tfrac{\beta^D\Pi^D+\beta^M\Pi^M}{E}\right)\bar{\mu}^M M - \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{\Pi_{gf}}{1+\omega^W\beta^q_{gf}}\right)\eta d\log c^M \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\Pi_{gf}\frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\Pi_{gf}\frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \end{aligned} . \tag{B.16}$$

The second is the component associated with distortions created by the initial tariffs (TD):

$$\begin{aligned} dC^{\text{TD}} = \; & -\chi \quad \left(-\beta^M\tfrac{T}{E}\bar{\mu}^M M + \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{T_{gf}}{1+\omega^W\beta^q_{gf}}\right)\eta d\log c^M \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}T_{gf}\frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}T_{gf}\frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}\frac{\theta}{1+\omega^W\theta}(d\log(1+\tau_{og})-d\log c_{gf}) \end{aligned} . \tag{B.17}$$

The last term is the change in terms of trade associated with the change in world prices (ToT):

$$
\begin{aligned}
dC^{\text{ToT}} = \quad & -\chi\omega^W \quad \left(-\beta^M \tfrac{V}{E}\bar{\mu}^M M + \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} \frac{v_{ogf}}{1+\omega^W\beta^q_{gf}}\right)\eta d\log c^M \\
& -\chi\omega^W \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} \omega^W v_{ogf}\frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\
& -\chi\omega^W \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} v_{ogf}\frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \\
& -\chi\omega^W \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{o} v_{ogf}\frac{\theta}{1+\omega^W\theta}(d\log(1+\tau_{og}) - d\log c_{gf})
\end{aligned}
\tag{B.18}
$$

B.1.5 Measurement

To compute dC in (B.15), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to: (i) the elasticity parameters of the foreign export demand and import supply curves, $\{\sigma^W, \omega^W\}$; (ii) labor payments in domestic and exporter firms, $\{W^D, W^X\}$; and (iii) aggregate expenditure, E.

B.2 Intermediate Production

B.2.1 Environment

We consider an environment similar to that of our baseline model, but we now classify goods into sectors $k \in \mathcal{K}$. Let $\mathcal{G}^h_k$ be the set of goods in sector k with $h \in \{D, M, X\}$, and $\mathcal{G}^h \equiv \cup_{k\in\mathcal{K}}\mathcal{G}^h_k$.

Preferences. Workers and owners have identical homothetic preferences given by

$$C = \Pi_{k\in\mathcal{K}}(C_k)^{\gamma_k} \tag{B.19}$$

$$C_k = \left[\sum_{g\in\mathcal{G}^D_k\cup\mathcal{G}^M_k}(a_g)^{\frac{1}{\eta_k}}(C_g)^{\frac{\eta_k-1}{\eta_k}}\right]^{\frac{\eta_k}{\eta_k-1}}, \tag{B.20}$$

$$C_g = \left[\sum_{f\in\mathcal{F}_g}(a_{gf})^{\frac{1}{\sigma_k}}(C_{gf})^{\frac{\sigma_k-1}{\sigma_k}}\right]^{\frac{\sigma_k}{\sigma_k-1}}, \tag{B.21}$$

with $\sum_{k\in\mathcal{K}}\gamma_k = \sum_{g\in\mathcal{G}^D_k\cup\mathcal{G}^M_k} a_g = \sum_{f\in\mathcal{F}_g} a_{gf} = 1$.

Technology. We maintain the same technology for importer and exporter firms. However, we now allow domestic firms to use intermediate inputs. For all firms $f \in \mathcal{F}_g$ producing good $g \in \mathcal{G}^D_k$,

$$y_{gf} = z_{gf}(L_{gf})^{\alpha^L_k}(I_{gf})^{\alpha^I_k}, \quad \alpha^L_k + \alpha^I_k = 1.$$

Following the standard in quantitative trade models (Costinot and Rodríguez-Clare, 2014), we assume that production follows a nesting structure identical to that of final demand. For all firms

in sector k,

$$I_{gf} = \Pi_{k \in \mathcal{K}} (q^I_{k',gf})^{\phi_{k'k}} \tag{B.22}$$

where $\sum_{k' \in \mathcal{K}} \phi_{k'k} = 1$ and

$$q^I_{k',gf} = \left[\sum_{g' \in \mathcal{G}^D_k \cup \mathcal{G}^M_k} (a_{g'})^{\frac{1}{\eta_k}} (q^I_{g',gf})^{\frac{\eta_k - 1}{\eta_k}} \right]^{\frac{\eta_k}{\eta_k - 1}}, \tag{B.23}$$

$$q^I_{g',gf} = \left[\sum_{f' \in \mathcal{F}_{g'}} (a_{g'f'})^{\frac{1}{\sigma_k}} (q^I_{g'f',gf})^{\frac{\sigma_k - 1}{\sigma_k}} \right]^{\frac{\sigma_k}{\sigma_k - 1}}. \tag{B.24}$$

Note that, except for Cobb-Douglas parameters, all the shifters and elasticities are the same for final and intermediate consumption.

Market Structure. We maintain the same market structure as in the baseline model, and assume that the parameter condition holds for all sectors and goods, $1 < \eta_k \leq \sigma_k \leq \eta_k^2$ for all $g \in \mathcal{G}^D_k \cup \mathcal{G}^M_k$.

Market Clearing. Labor supply must be equal to the labor demand of domestic firms:

$$\bar{L}^D = \sum_{g \in \mathcal{G}^D} \sum_{f \in \mathcal{F}_g} \ell_{gf}. \tag{B.25}$$

For domestic good market to clear, we must have that

$$q_{gf} = \sum_{g' \in \mathcal{G}^D} \sum_{f' \in \mathcal{F}_g} q^I_{gf,g'f'} + C_{gf}. \quad \forall g \in \mathcal{G}^D \cup \mathcal{G}^M \tag{B.26}$$

From the budget constraint, aggregate domestic spending must be equal to the income from labor, profits and tariff revenue:

$$F = w\bar{L}^D + \sum_{g \in \mathcal{G}^D \cup \mathcal{G}^M \cup \mathcal{G}^X} \sum_{f \in \mathcal{F}_g} \Pi_{gf} + T. \tag{B.27}$$

Equilibrium. The equilibrium is similar to that of baseline model. There are two main differences that we now discuss.

First, cost minimization implies that the marginal cost of domestic firms f producing a variety of good $g \in \mathcal{G}^D_k$ is

$$c_{gf} = (1/z_{gf})(w/\alpha^L_k)^{\alpha^L_k} (P^I_k/\alpha^I_k)^{\alpha^I_k}, \tag{B.28}$$

with $P^I_k \equiv \Pi_{k'} (P_{k'})^{\phi_{k'k}}$. Given total quantity sold by firm f of q_{gf}, labor spending is $w\ell_{gf} = \alpha^L_k c_{gf} q_{gf}$, and intermediate spending on sector k' is $I_{k,gf} \equiv P_k q^I_{k,gf} = \alpha^I_g c_{gf} q_{gf}$.

Second, in each sector, domestic demand takes the form in (A.1) with the demand shifter given by

$$Q_k = (P_k)^{\eta_k - 1} E_k \quad \text{and} \quad (P_k)^{1-\eta_k} = \sum_{g \in \mathcal{G}_k^D \cup \mathcal{G}_k^M} (a_g)(P_g)^{1-\eta_k}, \tag{B.29}$$

where E_k is the country's aggregate expenditure in sector k,

$$E_k = \gamma_k F + \sum_{k' \in \mathcal{K}} \phi_{kk'} \alpha_{k'}^I \sum_{g \in \mathcal{G}_{k'}^D} \sum_{f \in \mathcal{F}_g} c_{gf} q_{gf}. \tag{B.30}$$

B.2.2 Firm-level Responses

Importer Firms. Given their sector's demand shifter, importer firms behave as in our baseline model. Given the demand shifter $d \log Q_k$, imports of firm f producing a variety of good $g \in \mathcal{G}_k^M$ are given by $d \log q_{ogf}$ and $d \log q_{gf}$ in (A.22)–(A.23), with $d \log c_g$ and $d \log c_{gf}$ defined in (A.16) and (A.21), respectively.

Domestic Firms. For all $g \in \mathcal{G}^D$, (B.28) implies that $d \log c_{gf} = d \log c_k^D$ and, thus, $d \log P_g = d \log p_{gf} = d \log c_k^D$. For all firms producing $g \in \mathcal{G}_k^D$, (A.18) implies that

$$d \log q_{gf} = d \log q_k^D = -\eta d \log c_k^D + d \log Q_k, \tag{B.31}$$

where

$$d \log c_k^D = \alpha_k^L d \log w + \alpha_k^I \sum_{k'} \phi_{k'k} d \log P_{k'}. \tag{B.32}$$

B.2.3 Aggregate Responses

In sector k, the change in the price index is

$$d \log P_k = e_k^D d \log c_k^D + e_k^M d \log c_k^M$$

with $d \log c_k^M \equiv \sum_{g \in \mathcal{G}_k^M} e_g^M d \log c_g$, $e_g^M \equiv \bar{\mu}_g^M M_g / \sum_{g' \in \mathcal{G}_k^M} \bar{\mu}_{g'}^M M_{g'}$. Thus,

$$d \log P_k - e_k^D \alpha_k^I \sum_{k'} \phi_{k'k} d \log P_{k'} = e_k^D \alpha_k^L d \log w + e_k^M d \log c_k^M$$

which implies that

$$d \log P_k = \alpha_k^{Pw} d \log w + \sum_{k'} \alpha_{kk'}^{PM} e_{k'}^M d \log c_{k'}^M \tag{B.33}$$

with $[\alpha_{kk'}^{PM}] \equiv (I - [e_k^D \alpha_k^I \phi_{k'k}])^{-1}$ and $\alpha_k^{Pw} \equiv \sum_{k'} \alpha_{kk'}^{PM} e_{k'}^D \alpha_{k'}^L$.

This implies that

$$d \log c_k^D = \alpha_k^{Dw} d \log w + \sum_{k'} \alpha_{kk'}^{DM} d \log c_{k'}^M$$

with $\alpha^{DM}_{kk'} \equiv \alpha^I_k \sum_{k'} \phi_{kk'} \alpha^{PM}_{sk'} e^M_{k'}$ and $\alpha^{Dw}_k \equiv \alpha^L_k + \sum_{k'} \phi_{k'k} \alpha^{Pw}_{k'}$.

From (B.30),

$$d \log E_k = b_k d \log F + \sum_{k' \in \mathcal{K}} b_{kk'} (d \log c^D_{k'} + d \log q^D_{k'})$$

where $b_k \equiv \gamma_k F / E_k$ and $b_{kk'} \equiv \phi_{kk'} \frac{\alpha^I_{k'}}{\alpha^L_{k'}} \frac{wL_k}{E_k}$, with $L_k \equiv \sum_{g \in \mathcal{G}^D_{k'}} \sum_{f \in \mathcal{F}_g} L_{gf}$.

By denoting $d \log \tilde{E}_k = d \log E_k - d \log P$, we can write

$$\begin{aligned} d \log \tilde{E}_k &= b_k d \log C + \textstyle\sum_{k' \in \mathcal{K}} b_{kk'} ((1 - \eta_{k'})(d \log c^D_{k'} - d \log P_{k'}) + d \log \tilde{E}_{k'}) \\ &= b_k d \log C + \textstyle\sum_{k' \in \mathcal{K}} b_{kk'} ((1 - \eta_{k'}) e^M_{k'} (d \log c^D_{k'} - d \log c^M_k) + d \log \tilde{E}_{k'}) \end{aligned}$$

and, thus,

$$d \log \tilde{E}_k \equiv \beta^E_k d \log C + \sum_{k' \in \mathcal{K}} \beta^E_{kk'} (1 - \eta_{k'}) e^M_{k'} (d \log c^D_{k'} - d \log c^M_{k'})$$

with $[\beta^E_{kk'}] \equiv (I - [b_{kk'}])^{-1}$ and $\beta^E_k \equiv \sum_{k'} \beta^E_{kk'} b_{k'}$.

The labor market clearing condition is

$$d \log w = \sum_k w \ell_k ((1 - \eta_k) e^M_{k'} (d \log c^D_{k'} - d \log c^M_{k'}) + d \log \tilde{E}_{k'})$$

which implies that

$$d \log w = \beta^{wC} d \log C + \sum_k \beta^{wM}_k d \log c^M_k \tag{B.34}$$

with $\beta^w \equiv (1 - [w\ell_k]' (I + \beta^E) diag((1 - \eta_k) e^M_{k'}) [\alpha^{Dw}_k])^{-1}$, $\beta^{wC} = \beta^w \sum_k w \ell_k \beta^E_k$ and $\beta^{wM} \equiv \beta^w [w\ell_k]' (I + \beta^E) diag((1 - \eta_k) e^M_{k'}) (\alpha^{DM} - I)$.

Thus,

$$d \log c^D_k - d \log c^M_k = \tilde{\beta}^{DC}_k d \log C + \sum_{k'} \tilde{\beta}^{DM}_{kk'} d \log c^M_{k'}$$

$$d \log \tilde{E}_k = \tilde{\beta}^{EC}_k d \log C + \sum_{k'} \tilde{\beta}^{EM}_{kk'} d \log c^M_{k'}$$

with $\tilde{\beta}^{DC}_k \equiv \alpha^{Dw}_k \beta^{wC}$, $\tilde{\beta}^{DM}_{kk'} \equiv (\alpha^{Dw}_k \beta^{wM}_{k'} + \alpha^{DM}_{kk'} - \mathbb{I}_{k=k'})$, $\tilde{\beta}^{EC}_k \equiv \beta^E_k - \sum_{k' \in \mathcal{K}} \beta^E_{kk'} (1 - \eta_{k'}) e^M_{k'} \beta^{DC}_{k'}$, and $\tilde{\beta}^{EM}_{kk'} \equiv \sum_{k''} \beta^E_{kk''} (1 - \eta_{k''}) e^M_{k''} \beta^{DM}_{k''k'}$.

We can then solve for the change in quantity for domestic firms using (B.31):

$$\begin{aligned} d \log q^D_k &= -\eta_k e^M_k (d \log c^D_k - d \log c^M_k) + d \log \tilde{E}_k \\ &= \beta^{DC}_k d \log C + \textstyle\sum_{k'} \beta^{DM}_{kk'} d \log c^M_{k'} \end{aligned} \tag{B.35}$$

with $\beta^{DC}_k \equiv -\eta_k e^M_k \tilde{\beta}^{DC}_k + \tilde{\beta}^{EC}_k$ and $\beta^{DM}_{kk'} \equiv -\eta_k e^M_k \tilde{\beta}^{DM}_{kk'} + \tilde{\beta}^{EM}_{kk'}$.

We can also solve for the demand shifter:

$$\begin{aligned} d \log Q_k &= \eta_k d \log c^M_k + \eta_k e^D_k \left(d \log c^D_k - d \log c^M_k \right) + d \log \tilde{E}_k \\ &= \eta_k d \log c^M_k + \beta^{MC}_k d \log C + \textstyle\sum_{k'} \beta^{MM}_{kk'} d \log c^M_{k'} \end{aligned}$$

with $\beta_k^{MC} \equiv \eta_k e_k^D \tilde{\beta}_k^{DC} + \tilde{\beta}_k^{EC}$ and $\beta_{kk'}^{MM} \equiv \eta_k e_k^D \tilde{\beta}_{kk'}^{DM} + \tilde{\beta}_{kk'}^{EM}$.

Together with (A.23), this implies that, for all $g \in \mathcal{G}_k^M$,

$$\begin{aligned} d\log q_{gf} = & - \beta_{gf}^q (d\log c_{gf} - d\log c_g) \\ & - \eta_k (d\log c_g - d\log c_k^M) \\ & + \textstyle\sum_{k'} \beta_{kk'}^{MM} d\log c_{k'}^M + \beta_k^{MC} d\log C. \end{aligned} \tag{B.36}$$

B.2.4 Aggregate Welfare

Consumption Price index. Let us write the change in the price index as

$$d\log P^C = \sum_{g \in \mathcal{G}^D \cup \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \frac{p_{gf} C_{gf}}{F} d\log p_{gf}, \tag{B.37}$$

with C_{gf} the final consumption of firm f producing good g.

Firms. For every firm, we can write the change in profits as

$$d\Pi_{gf} = q_{gf}(dp_{gf} - dc_{gf}) + (p_{gf} - c_{gf}) dq_{gf} \tag{B.38}$$

From the cost minimization problem, the Envelope theorem implies that

$$q_{gf} dc_{gf} = L_{gf} dw + \sum_{g' \in \mathcal{G}^D \cup \mathcal{G}^M} \sum_{f' \in \mathcal{F}_g} q_{g'f',gf}^I dp_{g'f'} + \sum_o q_{ogf}^M (dp_{og}^W + d(p_{og}^W \tau_{og})). \tag{B.39}$$

Tariff revenue. The expression for tariff revenue in (A.11) implies that

$$dT = \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_o \left(\tau_{og} p_{og}^W dq_{ogf} + q_{ogf} d(\tau_{og} p_{og}^W) \right). \tag{B.40}$$

Aggregate Real Spending. By definition, the change in aggregate real spending is:

$$dC \equiv F d\log C = dF - F d\log P = dw\bar{L} + d\Pi^M + d\Pi^D + d\Pi^X + dT - F d\log P^C.$$

Using the expressions for the changes in the price index in (B.37), profits in (B.38) and tariff revenue in (B.40), we obtain

$$\begin{aligned} dC = & \quad dw\bar{L}^D \\ & + \textstyle\sum_{g \in \mathcal{G}^D \cup \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \left(q_{gf}(dp_{gf} - dc_{gf}) + (p_{gf} - c_{gf}) dq_{gf} \right) \\ & + \textstyle\sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_o \left(\tau_{og} p_{og}^W dq_{ogf} + q_{ogf} d(\tau_{og} p_{og}^W) \right) \\ & - \textstyle\sum_{g \in \mathcal{G}^D \cup \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} C_{gf} dp_{gf} \end{aligned}$$

Substituting for the market clearing conditions in (B.25)–(B.26) and the change in costs in (B.39), this expression becomes:

$$\begin{aligned} dC \;=\;& dw\left(\textstyle\sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\ell_{gf}\right)\\ +\;& \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(p_{gf}-c_{gf})dq_{gf}\\ +\;& \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(\sum_{g'\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f'\in\mathcal{F}_g}q^I_{gf,g'f'}+C_{gf}\right)dp_{gf}\\ -\;& \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(L_{gf}dw+\sum_{g'\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f'\in\mathcal{F}_g}q^I_{g'f',gf}dp_{g'f'}+\sum_o q_{ogf}(dp^W_{og}+d(p^W_{og}\tau_{og}))\right)\\ +\;& \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o\left(\tau_{og}p^W_{og}dq_{ogf}+q_{ogf}d(\tau_{og}p^W_{og})\right)\\ -\;& \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}C_{gf}dp_{gf} \end{aligned}$$

Rearranging this expression, we obtain the change in aggregate welfare:

$$\begin{aligned} dC \;=\;& \textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}(p_{gf}-c_{gf})dq_{gf}\\ +\;& \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o\tau_{og}p^W_{og}dq^M_{ogf}\\ -\;& \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o q^M_{ogf}dp^W_{og} \end{aligned}$$

which implies that

$$\begin{aligned} dC \;=\;& \textstyle\sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\Pi_{gf}d\log q_{gf}\\ +\;& \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}d\log q_{ogf}\\ -\;& \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf}d\log p^W_{og} \end{aligned} \tag{B.41}$$

with $\Pi_{gf}\equiv c_{gf}q_{gf}(\mu_{gf}-1)$, $T_{ogf}\equiv\tau_{og}v_{ogf}$ and $v_{ogf}\equiv p^W_{og}q_{ogf}$. We can then use these three terms to define the three components of welfare changes: markup distortions (first row), tariff distortions (second row), and terms of trade changes (last row).

By plugging (B.35)–(B.36) into (B.41),

$$\begin{aligned} dC = \;& +\chi & & \textstyle\sum_k\chi_k d\log c^M_k\\ & -\chi & & \textstyle\sum_{g\in\mathcal{G}^M}(\Pi_g+T_g)\eta_k(d\log c_g-d\log c^M_k)\\ & -\chi & & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})\beta^q_{gf}(d\log c_{gf}-d\log c_g)\\ & -\chi & & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}\theta(d\log p_{og}-d\log c_{gf})\\ & -\chi & & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf}d\log p^W_{og} \end{aligned} \tag{B.42}$$

with $\chi\equiv 1-\sum_k\frac{\Pi^M_k+T_k}{F}\beta^{MC}_k+\sum_k\frac{\Pi^D_k}{F}\beta^{DC}_k$ and $\chi_k\equiv\sum_{k'}(\Pi^M_{k'}+T_{k'})\beta^{MM}_{k'k}+\Pi^D_{k'}\beta^{DM}_{k'k}$.

B.2.5 Measurement

To compute dC in (B.42), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to the following variables in national accounts: for each sector, final spending, intermediate spending and labor payments, $\{I_{k'k}, W_k, F_k\}$.

To see this, note that we can compute technology parameters for domestic firms as $\phi_{k'k}=$

$I_{k'k}/\sum_{k'} I_{k'k}$ and $\alpha_k^L = W_k/(W_k + \sum_{k'} I_{k'k})$. Since only domestic firms use inputs, we can use the model identities to compute domestic profits: $\Pi_k^D = F_k + \sum_{k'} I_{kk'} - M_k \bar{\mu}_k^M - W_k - \sum_{k'} I_{k'k}$.

B.3 Homothetic Preferences Across Goods

B.3.1 Environment

Everything remains as in our baseline model, but we now assume that domestic demand is such that

$$q_{gf} = a_{gf}(p_{gf})^{-\sigma}(P_g)^{\sigma-1}e_g(\mathcal{P})E$$

with $\mathcal{P} \equiv \{P_g\}_{g \in \mathcal{G}^M \cup \mathcal{G}^D}$ and P_g the CES price index for good g. The function $e_g(\mathcal{P})$ is a general demand that determines the share of aggregate spending on good g. It is useful to define the following elasticity matrices:

$$\eta_{gg'} \equiv \frac{\partial \log e_g(\mathcal{P})}{\partial \log P_{g'}} \quad \text{and} \quad \gamma_{gg'} \equiv \frac{1}{\sigma - 1}\frac{\eta_{gg}}{\sigma - 1 + \eta_{gg}}\frac{\partial^2 \log e_g(\mathcal{P})}{\partial \log P_g \partial \log P_{g'}}.$$

The equilibrium remains the same as in our baseline model, but the firm's perceived elasticity of demand is now given by

$$\varepsilon_{gf} = \sigma - (\sigma - 1 + \eta_{gg})e_{gf}.$$

B.3.2 Firm-level Responses

We start by totally differentiating the price system as a function of the firm's marginal costs:

$$d\log p_{gf} = d\log c_{gf} - \frac{1}{\varepsilon_{gf}(\varepsilon_{gf} - 1)}d\varepsilon_{gf}$$

with

$$d\varepsilon_{gf} = (\sigma - 1)(\sigma - 1 + \eta_{gg})e_{gf}\left(d\log p_{gf} - d\log P_g - \sum_{g'}\gamma_{gg'}d\log P_{g'}\right).$$

Thus,

$$d\log p_{gf} = \beta_{gf}^p d\log c_{gf} + (1 - \beta_{gf}^p)\left(d\log P_g + \sum_{g'}\gamma_{gg'}d\log P_{g'}\right) \tag{B.43}$$

where, as before, $\rho_{gf} \equiv (\sigma - \varepsilon_{gf})(\sigma - 1)/\varepsilon_{gf}(\varepsilon_{gf} - 1)$ and $\beta_{gf}^p \equiv 1/(1 + \rho_{gf})$.

By aggregating across firms, we can then solve for the change in the price index. Since $d\log P_g = \sum_{f \in \mathcal{F}_g} e_{gf} d\log p_{gf}$,

$$d\log P_g = \sum_{f \in \mathcal{F}_g}\omega_{gf}d\log c_{gf} + \sum_{g'}\tilde{\gamma}_{gg'}d\log P_{g'}$$

where $\omega_{gf} \equiv e_{gf}\beta^p_{gf} / \sum_{f\in\mathcal{F}_g} e_{gf}\beta^p_{gf}$ and $\tilde{\gamma}_{gg'} \equiv \frac{1-\sum_f e_{gf}\beta^p_{gf}}{\sum_f e_{gf}\beta^p_{gf}}\gamma_{gg'}$. By defining $\beta^P \equiv (I-\tilde{\gamma})^{-1}$,

$$d\log P_g = \sum_{g'} \beta^P_{gg'} \sum_{f\in\mathcal{F}_{g'}} \omega_{g'f} d\log c_{g'f}. \tag{B.44}$$

For domestic firms $g \in \mathcal{G}^D$, $d\log c_{gf} = d\log w$ and, thus,

$$d\log P_g = \beta^{Pw}_g d\log w + d\log c^P_g,$$

with $\beta^{Pw}_g \equiv \sum_{g'\in\mathcal{G}^D} \beta^P_{gg'}$ and $d\log c^P_g \equiv \sum_{g'\in\mathcal{G}^M} \beta^P_{gg'} \sum_{f\in\mathcal{F}_{g'}} \omega_{g'f} d\log c^M_{g'f}$.

In addition, we can define:

$$d\log P_g + \sum_{g'} \gamma_{gg'} d\log P_{g'} = \beta^w_g d\log w + d\log c^q_g$$

with $\beta^w_g \equiv \beta^{Pw}_g + \sum_{g'} \gamma_{gg'}\beta^{Pw}_{g'}$ and $d\log c^q_g \equiv d\log c^P_g + \sum_{g'} \gamma_{gg'} d\log c^P_{g'}$.

We can then solve for firm-level outcomes as a function of exogenous changes in import costs and endogenous changes in wages and aggregate consumption:

$$d\log \mu_{gf} = -\beta^\mu_{gf}\left(d\log c_{gf} - \beta^w_g d\log w - d\log c^q_g\right)$$

with $\beta^\mu_{gf} \equiv (1-\beta^p_{gf}) \in (0,1)$.

We can then solve for quantity as a function of wages and aggregate consumption:

$$d\log q_{gf} = -\beta^q_{gf}\left(d\log c_{gf} - (\beta^w_g d\log w + d\log c^q_g)\right) + \sum_{g'} \beta^q_{gg'}\left(\beta^{Pw}_{g'} d\log w + d\log c^P_{g'}\right) + d\log C \tag{B.45}$$

where $\beta^q_{gf} \equiv \sigma\beta^p_{gf}$ and $\beta^q_{gg'} \equiv \eta_{gg'} + e_{g'} - \sigma\gamma_{gg'} - \mathbb{I}_{g=g'}$.

B.3.3 Aggregate Responses

We now turn to the responses in aggregate variables. We only need to solve for the change in wages. Note that, because of the general preferences across goods, domestic firms producing different goods react deferentially to changes in the import costs. For all domestic firms producing a variety of good $g \in \mathcal{G}^D$,

$$d\log q_{gf} = -\beta^q_{gf}\left((1-\beta^w_g)d\log w - d\log c^q_g\right) + \sum_{g'} \beta^q_{gg'}\left(\beta^{Pw}_{g'} d\log w + d\log c^P_{g'}\right) + d\log C.$$

Together with the labor market clearing condition, this implies that

$$d\log w = \beta^w(d\log c^w + d\log C) \tag{B.46}$$

where

$$d\log c^w \equiv \sum_{g\in\mathcal{G}^D} \ell_g \left[-(\sum_{f\in\mathcal{F}_g} \ell_{gf}\beta^q_{gf}) d\log c^q_g + \sum_{g'} \beta^q_{gg'} d\log c^P_{g'} \right],$$

$$(\beta^w)^{-1} \equiv \sum_{g\in\mathcal{G}^D} \ell_g \left[(\sum_{f\in\mathcal{F}_g} \ell_{gf}\beta^q_{gf})(1-\beta^w_g) - \sum_{g'} \beta^q_{gg'}\beta^{Pw}_{g'} \right],$$

with $\ell_{gf} = L_{gf}/L_g$ and $L_g = \sum_{f\in\mathcal{F}_g} L_{gf}$.

Thus, (B.45) and (B.46) imply that

$$\begin{array}{rcl} d\log q_{gf} & = & -\beta^q_{gf}\left(\mathbb{I}_{g\in\mathcal{G}^M} d\log c_{gf} - d\log c^q_g\right) + \sum_{g'}\beta^q_{gg'} d\log c^P_{g'} \\ & + & \beta^{qw}_{gf}\beta^w d\log c^w + (1+\beta^{qw}_{gf}\beta^w) d\log C \end{array} \tag{B.47}$$

where $\beta^{qw}_{gf} \equiv \beta^q_{gf}(\beta^w_g - \mathbb{I}_{g\in\mathcal{G}^D}) + \sum_{g'}\beta^q_{gg'}\beta^{Pw}_{g'}$.

B.3.4 Aggregate Welfare

We note that the same steps used in Section (A.3.3) yields the following analog of expression (A.37):

$$\begin{array}{rcl} dC & = & \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf}) d\log q_{gf} \\ & - & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{o\in\mathcal{O}} T_{ogf}\theta(d\log p_{og} - d\log c_{gf}) \\ & - & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{o\in\mathcal{O}} v_{ogf} d\log p^W_{og} \end{array} \tag{B.48}$$

where $T_{gf} = 0$ for all $g \in \mathcal{G}^D$ and $\mathcal{G} \equiv \mathcal{G}^D \cup \mathcal{G}^M$.

By plugging (B.47) into (B.48), we get that

$$\begin{array}{rcl} dC = & +\chi & \left(\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})\beta^{qw}_{gf}\beta^w\right) d\log c^w \\ & -\chi & \sum_{g\in\mathcal{G}}(\Pi_g + T_g)\sum_{g'}\beta^q_{gg'} d\log c^P_{g'} \\ & -\chi & \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})\beta^q_{gf}\left(\mathbb{I}_{g\in\mathcal{G}^M} d\log c_{gf} - d\log c^q_g\right) \\ & -\chi & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{o\in\mathcal{O}} T_{ogf}\theta(d\log p_{og} - d\log c_{gf}) \\ & -\chi & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{o\in\mathcal{O}} v_{ogf} d\log p^W_{og} \end{array} \tag{B.49}$$

where

$$\chi^{-1} \equiv 1 - \frac{M}{E}\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}\frac{(\Pi_{gf}+T_{gf})}{M}(1+\beta^{qw}_{gf}\beta^w).$$

Again, we split this equation into three parts. The component associated with change in terms of trade is still given by (A.41). The component associated with markup distortions (MD):

$$\begin{array}{rcl} dC^{\text{MD}} = & +\chi & (\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}\Pi_{gf}\beta^{qw}_{gf}\beta^w) d\log c^w \\ & -\chi & \sum_{g\in\mathcal{G}}\Pi_g\sum_{g'}\beta^q_{gg'} d\log c^P_{g'} \\ & -\chi & \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}\Pi_{gf}\beta^q_{gf}\left(\mathbb{I}_{g\in\mathcal{G}^M} d\log c_{gf} - d\log c^q_g\right) \end{array} . \tag{B.50}$$

The second is the component associated with distortions created by the initial tariffs (TD):

$$\begin{aligned} d\mathcal{C}^{\text{TD}} = \quad & -\chi \quad (\textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g} T_{gf}\beta_{gf}^{qw}\beta^{w})d\log c^{w} \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}} T_g \sum_{g'} \beta_{gg'}^{q} d\log c_{g'}^{P} \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g} T_{gf}\beta_{gf}^{q}\left(\mathbb{I}_{g\in\mathcal{G}^M} d\log c_{gf} - d\log c_g^{q}\right) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{o\in\mathcal{O}} T_{ogf}\theta(d\log p_{og} - d\log c_{gf}) \end{aligned} . \tag{B.51}$$

B.3.5 Measurement

To compute $d\mathcal{C}$ in (B.51), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to: (i) firm-level employment data, $\{L_{gf}\}$; and (ii) the good-level demand function, $e_g(\mathcal{P})$.

To see this, note that the definition of β_{gf}^{q} is identical to that of our baseline model, so that $\mu_{gf} = \mathcal{M}(\beta_{gf}^{q})$ with $\mathcal{M}(.)$ defined in (A.15). We can then use $e_g(\mathcal{P})$ to compute $\eta_{gg'}$ and $\gamma_{gg'}$, which yields $\beta_{gg'}^{P}$, $\beta_{gg'}^{q}$, β_{g}^{w}, and β_{gf}^{qw}. Finally, we can combine firm-level markups with firm-level imports and employment to compute firm-level profits Π_{gf} and the aggregate multipliers β^{w}, χ and χ^{w}.

B.4 Homothetic Single Aggregator Across Firms

B.4.1 Environment

Everything remains as in our baseline model, but we now assume that demand takes the form of a nested extension of the homothetic single-aggregator demand in Matsuyama (2023). To simplify exposition, we maintain CES preferences across good with an elasticity of η. For firm $f \in \mathcal{F}_g$ producing a variety of good $g \in \mathcal{G}^M \cup \mathcal{G}^D$, domestic demand is

$$p_{gf}q_{gf} = \bar{e}_g(z_{gf})a_g\left(P_g/P\right)^{1-\eta}E \quad \text{such that} \quad z_{gf} \equiv a_{gf}p_{gf}/A_g, \tag{B.52}$$

where $\bar{e}_g(z)$ is a strictly decreasing function with elasticity $\sigma_g(z) \equiv -\partial\log\bar{e}_g(z)/\partial\log z$, and A_g is an endogenous demand aggregator, which is implicitly defined as

$$\sum_{f\in\mathcal{F}_g}\bar{e}_g(a_{gf}p_{fg}/A_g)) = 1. \tag{B.53}$$

Firm f's optimal price satisfies (2.2) with perceived demand elasticity given by

$$\varepsilon_{gf} = \varepsilon_g(z_{gf},\bar{\sigma}_g) \equiv 1 + \sigma_g(z_{gf}) - \mathbb{I}_O\left(\sigma_g(z_{gf})\frac{\sigma_g(z_{gf})}{\bar{\sigma}_g} - (\eta+1)\right)\bar{e}(z_{gf}) \tag{B.54}$$

where $\bar{\sigma}_g \equiv \sum_{f\in\mathcal{F}_g}\bar{e}(z_{gf})\sigma_g(z_{gf})$ and $\mathbb{I}_O$ is a dummy that equals one for our baseline oligopolistic market structure and zero for monopolistic competition. Note that this extended specification

covers our baseline specification with $A_g = P_g$ and $\varepsilon(z) = \sigma - (\sigma - \eta)e(z)$, but it also allows for variable markups under monopolitic competition.

In what follows, it will be useful to work with the transformation in terms of market share,

$$\varepsilon_{gf} = \varepsilon_g^e(e_{gf}, \bar{\sigma}_g) \equiv \varepsilon_g(\bar{e}_g^{-1}(z_{gf}), \bar{\sigma}_g) \quad \text{and} \quad \sigma_{gf} = \sigma_g^e(e_{gf}) \equiv \sigma(\bar{e}_g^{-1}(z_{gf})).$$

B.4.2 Firm-level Responses

We start by characterizing changes in firm-level outcomes as a function of exogenous changes in marginal costs.

As in our baseline model, all domestic firms have the same marginal cost change, so it is still true that, for all $g \in \mathcal{G}^D$,

$$d\log p_{gf} = d\log P^M + \frac{1}{\eta e^M} d\log C \quad \text{and} \quad d\log q_{gf} = 0. \tag{B.55}$$

Turning to importer firms, (2.2) and (B.54) imply that

$$d\log p_{gf} - d\log A_g = \beta_{gf}^p \left(d\log c_{gf} - d\log A_g + \beta_{gf}^{\bar{\sigma}} d\log \bar{\sigma}_g \right) \tag{B.56}$$

such that $\beta_{gf}^p = \beta_g^p(e_{gf})$ and $\beta_{gf}^{\bar{\sigma}} \equiv \beta_g^{\bar{\sigma}}(e_{gf})$, with

$$\beta_g^p(e) \equiv \frac{1}{1 - \frac{\sigma_g^e(e)}{\varepsilon_g^e(e,\bar{\sigma}_g)-1} \frac{\partial \log \varepsilon_g^e(e,\bar{\sigma}_g)}{\partial \log e}} \quad \text{and} \quad \beta_g^{\bar{\sigma}}(e) \equiv \frac{\mathbb{I}_O}{\varepsilon_g^e(e,\bar{\sigma}_g)(\varepsilon_g^e(e,\bar{\sigma}_g)-1)} \frac{(\sigma_g(e))^2 e}{\bar{\sigma}_g}.$$

The definitions of A_g and $\bar{\sigma}_g$ in (B.53) imply that

$$d\log A_g = \sum_{f \in \mathcal{F}_g} \varphi_{gf}^A d\log p_{gf} \quad \text{such that} \quad \varphi_{gf}^A \equiv \frac{e_{gf}\sigma_{gf}}{\sum_{f' \in \mathcal{F}_g} e_{gf'}\sigma_{gf}} \tag{B.57}$$

and

$$d\log \bar{\sigma}_g = -\sum_{f \in \mathcal{F}_g} \varphi_{gf}^{\bar{\sigma}} \left(d\log p_{gf} - d\log A_g \right) \quad \text{such that} \quad \varphi_{gf}^{\bar{\sigma}} \equiv \omega_{gf}^A \sigma_{gf} \left(1 + \frac{\partial \log \sigma^e(e_{gf})}{\partial \log e} \right). \tag{B.58}$$

For each good $g \in \mathcal{G}^M$, the system (B.56)–(B.58) determines $\{d\log p_{gf}\}_{f \in \mathcal{F}_g}$ as a function of marginal cost changes $\{d\log c_{gf}\}_{f \in \mathcal{F}_g}$:

$$d\log p_{gf} = \sum_{f' \in \mathcal{F}_g} \beta_{gf,gf'}^{pc} d\log c_{gf'}$$

with $\beta^{pc} \equiv (I + [(1 - \beta_{gf}^p)\varphi_{gf'}^A + \beta_{gf}^p \beta_{gf}^{\bar{\sigma}} \varphi_{gf}^{\bar{\sigma}}])^{-1}$.

Thus,

$$d\log A_g = d\log c_g^A \equiv \sum_{f\in\mathcal{F}_g} \omega_{gf}^A d\log c_{gf} \tag{B.59}$$

$$d\log P_g = d\log c_g^M \equiv \sum_{f\in\mathcal{F}_g} \omega_{gf}^P d\log c_{gf} \tag{B.60}$$

with $\omega_{gf}^A \equiv \sum_{f'\in\mathcal{F}_g} \varphi_{gf'}^A \beta_{gf',gf}^{pc}$ and $\omega_{gf}^P \equiv \sum_{f'\in\mathcal{F}_g} e_{gf'} \beta_{gf',gf}^{pc}$.

Note that $\sum_{f'\in\mathcal{F}_g} \beta_{gf,gf'}^{pc} = 1$ for all $f \in \mathcal{F}_g$, since the system determining prices is homogeneous of degree one. This implies that $\sum_{f\in\mathcal{F}_g} \omega_{gf}^A = \sum_{f\in\mathcal{F}_g} \omega_{gf}^P = 1$. Together with (B.58), this implies that

$$d\log \bar{\sigma}_g = \sum_{f\in\mathcal{F}_g} \omega_{gf}^{\bar{\sigma}} \left(d\log c_{gf} - d\log A_g\right) \tag{B.61}$$

with $\omega_{gf}^{\bar{\sigma}} \equiv -\sum_{f'\in\mathcal{F}_g} \varphi_{gf'}^{\bar{\sigma}} \beta_{gf',gf}^{pc}$.

Note that (B.56) implies the following relationship:

$$d\log P_g - d\log A_g = \sum_{f\in\mathcal{F}_g} e_{gf}\beta_{gf}^p (d\log c_{gf} - d\log A_g) + \beta_g^{\bar{\sigma}} d\log \bar{\sigma}_g \tag{B.62}$$

with $\beta_g^{\bar{\sigma}} \equiv \sum_{f\in\mathcal{F}_g} e_{gf}\beta_{gf}^{\bar{\sigma}}$.

Finally, (B.52)–(B.56) implies that the change in imports is

$$d\log q_{gf} \;=\; -\beta_{gf}^q (d\log c_{gf} - d\log A_g + \beta_{gf}^{\sigma} d\log \bar{\sigma}_g) + (1-\eta) d\log P_g - d\log A_g + d\log Q \;, \tag{B.63}$$

such that $\beta_{gf}^q = \beta_g^q(e_{gf})$ with

$$\beta_g^q(e) \equiv (1+\sigma_g(e))\beta_g^p(e).$$

B.4.3 Aggregate Responses

We can then immediately solve for the import price index using $d\log P_g$ in (B.60):

$$d\log P^M = d\log c^M \equiv \sum_{g\in\mathcal{G}^M} e_g^M d\log c_g^M$$

and, thus, the demand shifter change is

$$\begin{aligned} d\log Q &= \eta d\log P + d\log C \\ &= \eta\left(e^D d\log w + e^M d\log P^M\right) + d\log C \\ &= \eta d\log c^M + \tfrac{1}{e^M} d\log C. \end{aligned}$$

Thus, we can characterize firm-level import changes in terms of fundamentals and $d\log C$.

Equation (B.63) implies that

$$\begin{aligned} d\log q_{gf} &= -\beta^q_{gf}(d\log c_{gf} - d\log A_g) - \beta^q_{gf}\beta^\sigma_{gf} d\log \bar{\sigma}_g \\ &+ (d\log P_g - d\log A_g) - \eta(d\log P_g - d\log c^M) + \tfrac{1}{\epsilon^M} d\log C \end{aligned}.$$

Together with (B.59)–(B.62), this expression implies that

$$\begin{aligned} d\log q_{gf} = & - \beta^q_{gf}(d\log c_{gf} - d\log c^A_g) \\ & - \textstyle\sum_{f'\in\mathcal{F}_g}((\beta^q_{gf}\beta^\sigma_{gf} - \beta^q_g)\omega^{\bar{\sigma}}_{gf'} - e_{gf'}\beta^p_{gf'})(d\log c_{gf'} - d\log c^A_g) \\ & - \eta(d\log c^P_g - d\log c^M) \\ & + \tfrac{1}{\epsilon^M} d\log C. \end{aligned} \tag{B.64}$$

with $\beta^A_{gf,gf'} \equiv -(\beta^q_g - \beta^q_{gf}\beta^\sigma_{gf})\omega^{\bar{\sigma}}_{gf'} - e_{gf'}\beta^p_{gf'}$

B.4.4 Aggregate Welfare

In this model, (A.37) remains valid. We now plug (B.64) into (A.37) to obtain the following expression for welfare

$$\begin{aligned} dC = & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}(\Pi_g + T_g)\eta(d\log c^P_g - d\log c^M) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(\Pi_{gf} + T_{gf})(\beta^q_{gf} + \beta^A_{gf})(d\log c_{gf} - d\log c^A_g) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o T_{ogf}\theta(d\log p_{og} - d\log c_{gf}) \\ & -\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_o v_{ogf} d\log p^W_{og} \end{aligned} \tag{B.65}$$

with $\beta^A_{gf} \equiv \sum_{f'\in\mathcal{F}_g}(\Pi_{gf'} + T_{gf'})((\beta^q_{gf'}\beta^\sigma_{gf'} - \beta^q_g)\omega^{\bar{\sigma}}_{gf} - e_{gf}\beta^p_{gf})/(\Pi_{gf} + T_{gf})$.

B.4.5 Measurement

To compute dC in (B.65), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to the firm-level price elasticity function, $\beta^p_g(e)$.

To see this, note that the definition of $\beta^p_g(e)$ in (B.56) implies that

$$\beta^p_g(e) - 1 = \frac{\beta^p_g(e)\sigma^e_g(e)}{\varepsilon^e_g(e,\bar{\sigma}_g) - 1}\frac{\partial \log \varepsilon^e_g(e,\bar{\sigma}_g)}{\partial \log e}$$

which, combined with the definition of $\beta^q_g(e)$ in (B.63) , yields

$$(\beta^q_g(e) - \beta^p_g(e))\frac{\partial \log \varepsilon^e_g(e,\bar{\sigma}_g)}{\partial \log e} - (\beta^p_g(e) - 1)(\varepsilon^e_g(e,\bar{\sigma}_g) - 1) = 0 \tag{B.66}$$

with $\varepsilon^e_g(0,\bar{\sigma}_g) = \beta^q_g(0)/\beta^p_g(0)$. The solution of this differential equation yields $\varepsilon^e_g(e,\bar{\sigma}_g)$.

We can then compute firm-level markups and elasticities. First, we obtain $\varepsilon_{gf} = \varepsilon^e_g(e_{gf},\bar{\sigma}_g)$

and $\mu_{gf} = \varepsilon_{gf}/(\varepsilon_{gf} - 1)$. Second, since $\sigma_g^e(e) = \beta_g^q(e)/\beta_g^p(e)$, we also obtain $\bar{\sigma}_g = \sum_{f \in \mathcal{F}_g} e_{gf} \sigma_g^e(e_{gf})$, $\beta_{gf}^{\bar{\sigma}} = \beta_g^{\bar{\sigma}}(e_{gf})$, φ_{gf}^A, $\varphi_{gf}^{\bar{\sigma}}$, and β^{pc}. Finally, these elasticities we obtain the shares: ω_{gf}^A, ω_{gf}^P, and β_{gf}^A.

C Empirical Appendix

C.1 Data Construction

Table C.1: Countries and Years in Importer Database

Country	Years	Country	Years
Albania	2007 - 2022	Lao PDR	2015 - 2022
Burundi	2010 - 2022	Sri Lanka	2016 - 2022
Benin	2016 - 2021	Morocco	2002 - 2013
Bangladesh	2005 - 2016	Madagascar	2007 - 2021
Bulgaria	2001 - 2006	Mexico	2011 - 2022
Botswana	2004 - 2010	Macedonia	2008 - 2018
Chile	1997 - 2022	Montenegro	2004 - 2020
Cote d'Ivoire	2000 - 2021	Mauritius	2000 - 2022
Cameroon	2007 - 2017	Malawi	2005 - 2021
Colombia	1997 - 2022	Nepal	2011 - 2014
Comoros	2016 - 2022	Pakistan	2019 - 2022
Cabo Verde	2010 - 2021	Peru	2000 - 2021
Costa Rica	2010 - 2021	Paraguay	2000 - 2022
Dominican Republic	2002 - 2021	Romania	2005 - 2011
Ecuador	2002 - 2021	Rwanda	2002 - 2016
Egypt	2005 - 2016	Senegal	2000 - 2020
Ethiopia	2012 - 2021	El Salvador	2006 - 2021
Gabon	2009 - 2021	Serbia	2006 - 2019
Georgia	2000 - 2022	Sao Tome and Principe	2017 - 2019
Guinea Bissau	2012 - 2018	Togo	2015 - 2021
Guatemala	2005 - 2013	Timor-Leste	2018 - 2022
Honduras	2012 - 2022	Tanzania	2003 - 2021
Croatia	2007 - 2015	Uganda	2011 - 2020
Indonesia	2020 - 2020	Uruguay	2001 - 2022
India	2016 - 2022	Viet Nam	2018 - 2022
Jordan	2008 - 2021	Kosovo	2013 - 2019
Kenya	2006 - 2022	South Africa	2010 - 2021
Cambodia	2016 - 2022	Zambia	2010 - 2021
Armenia	2018 - 2022		

C.2 Estimation: Functional Basis for $\beta(m)$

This appendix details the estimation of the function $\beta(m)$. The empirical pattern in the data suggests a concave relationship that eventually flattens at high market shares. To capture this pattern, we adopt a piecewise function that combines linear and quadratic segments, following the spline regression approach described in Harrell (2015). This approach allows us to estimate a flexible, nonlinear relationship while maintaining both computational simplicity and the ability to impose economic structure through our choice of thresholds and functional form.

Given that m ranges between 0 and 1, we set threshold points at $m_1 = 0.05$ and $m_2 = 0.5$. The choice of $m_2 = 0.5$ reflects the sparsity of observations at high market shares (less than 5% of the sample has $m > 0.5$). We specify:

$$\beta(m) = \begin{cases} a_0 + a_1\, m & \text{if } m \leq m_1 \\ a_2 + a_3\, m + a_4\, m^2 & \text{if } m \in [m_1, m_2] \\ a_5 & \text{if } S \geq m_2 \end{cases} \tag{C.1}$$

To ensure the function is well-behaved at the threshold points, we impose continuity and differentiability at m_1 and m_2. The continuity conditions ensure the function has no jumps, while the differentiability conditions (also known as smooth pasting conditions) ensure there are no kinks.

Our goal is to transform this piecewise function into a form that facilitates straightforward estimation. Specifically,

$$\beta(m) = a_0 + a_1 H(m) \tag{C.2}$$

where $H(m)$ depends only on the threshold parameters m_1 and m_2. This transformation allows us to estimate $\beta(m)$ using a simple linear regression once we construct $H(m)$ from the data.

To derive $H(m)$, we first solve for the parameters a_2 through a_5 in terms of a_0 and a_1. Starting with the smooth pasting condition at m_2 and working backwards through the continuity conditions, we obtain expressions for all parameters. After substitution and rearrangement, we can write $H(m)$ in terms of three auxiliary functions:

$$\begin{aligned} \tilde{m}_1(m) &= \min\{m, m_1\} \\ \tilde{m}_2(m) &= \min\{m, m_2\} \\ \tilde{m}(m) &= \max\{\tilde{m}_2(m) - m_1, 0\} \end{aligned} \tag{C.3}$$

These auxiliary functions allow us to write:

$$H(m) = \tilde{m}_1(m) + \tilde{m}(m)\frac{2m_2 - (\tilde{m}_2(m) + m_1)}{2(m_2 - m_1)} \tag{C.4}$$

Given our chosen values of $m_1 = 0.05$ and $m_2 = 0.5$, we can construct $H(m)$ directly from the data. The estimation of $\beta(m)$ then reduces to a linear regression of the observed import elasticities on a constant and $H(m)$, where the estimated coefficients correspond to a_0 and a_1 respectively.

C.3 Additional Results

C.3.1 Between-Good Dispersion in Import Firm Concentration

Table C.2: Between-Good Dispersion in Import Firm Concentration vs. GDP/capita and Population – All Goods

	St. dev. of HHI across goods		
log GDP/Capita	-0.032***	-0.038***	-0.058
	(0.004)	(0.009)	(0.037)
log Population	-0.014***	-0.019**	-0.053
	(0.003)	(0.008)	(0.055)
log Imports		0.005	0.009
		(0.007)	(0.016)
R^2	0.364	0.366	0.762
Fixed Effects:			
Country	No	No	Yes
Year	Yes	Yes	Yes

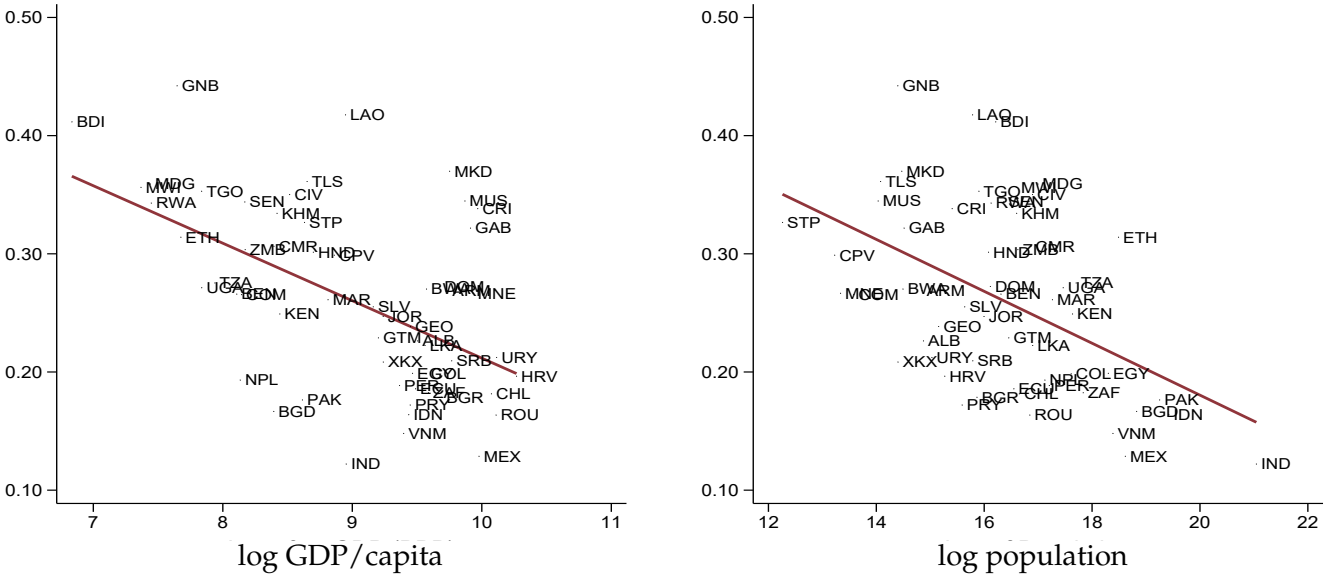
Note: Sample of 704 country-year observations. Columns report regressions of the import-weighted standard deviation of HHI across all imported goods for each country-year on log GDP per capita and log population. All regressions include year fixed effects. Standard errors clustered by country. *** p<0.01, ** p<0.05, * p<0.1

C.3.2 Average Import Firm Concentration

The average markup of imported goods increases with the average HHI of firm import shares across goods.[30] Thus, we measure a country's average import firm concentration as the import-weighted average of the HHI of firm import shares across goods.

Figure C.1 reports a scatter plot of each country's average import firm concentration against log GDP per capita (left panel) and log population (right panel), with values averaged over years in our sample. The figure shows that not only is the dispersion of concentration (both between and within goods) higher in poorer and smaller countries, but average import firm concentration is also higher in these countries. Table C.3 shows that our findings are robust to controlling for good-year fixed effects (column 1), the size of the import market (column 2), and country-good fixed effects (column 3).

Figure C.1: Average Import Firm Concentration Across Countries



Note: Figure shows average import firm concentration in the country against log GDP per capita (left panel) or log population (right panel) in our sample of 57 countries. For each country, average import firm concentration is the simple average across years of the import-weighted average across HS6 goods of their HHI of firm import shares.

[30] Using the same first-order approximation of a firm's markup around that of a firm with a negligible import share ($m \approx 0$), we obtain $\bar{\mu} = E_g[\bar{\mu}_g] \approx \sigma/(\sigma-1) + \kappa E_g[\text{HHI}_g]$, with $E_g[.]$ denoting the import-weighted average across goods.

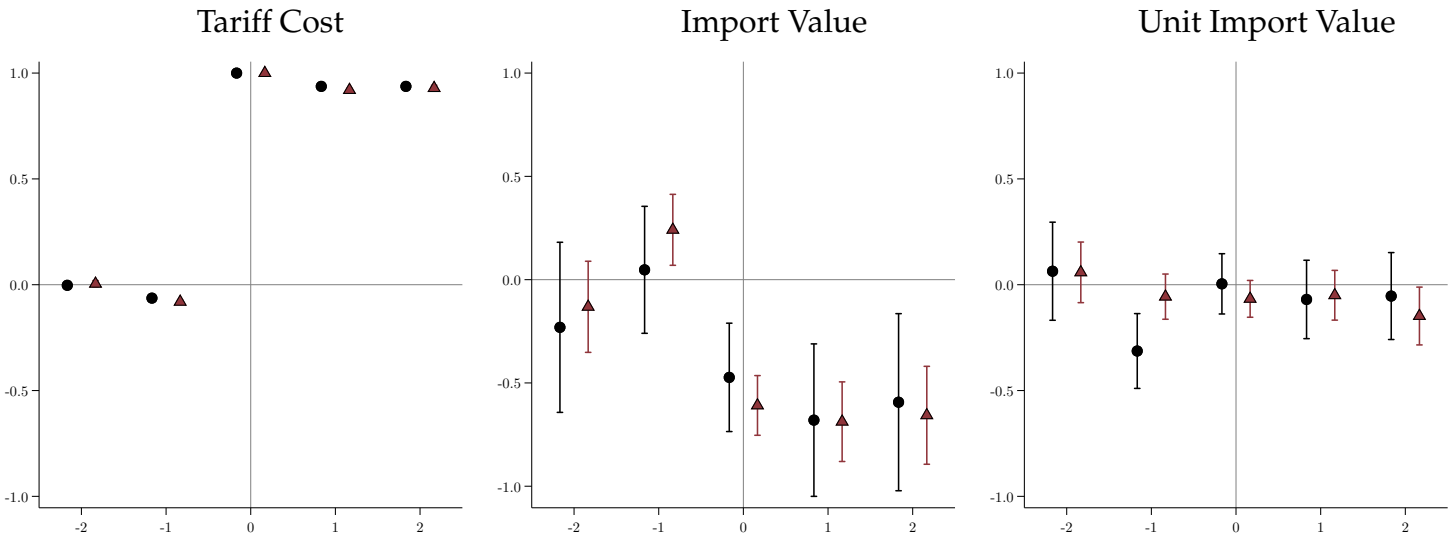
Table C.3: Average Import Firm Concentration vs. GDP/capita and Population

	HHI of firm import shares		
log GDP/capita	-0.059***	-0.064***	-0.181***
	(0.004)	(0.005)	(0.035)
log Population	-0.036***	-0.041***	-0.168***
	(0.003)	(0.004)	(0.044)
log Imports		0.005*	0.056***
		(0.003)	(0.004)
R^2	0.584	0.584	0.883
Fixed Effects:			
HS6-Country	No	No	Yes
HS6-Year	Yes	Yes	Yes

Note: Sample of 2,498,588 HS6-country-year observations. Table shows coefficients from regressions of HHI of firm import shares in each HS6-country-year on the variables listed on the rows. All regressions include HS6-year and year fixed effects. Observations weighted by its share of the country's imports in a given year. Standard errors clustered by country. *** p<0.01, ** p<0.05, * p<0.1

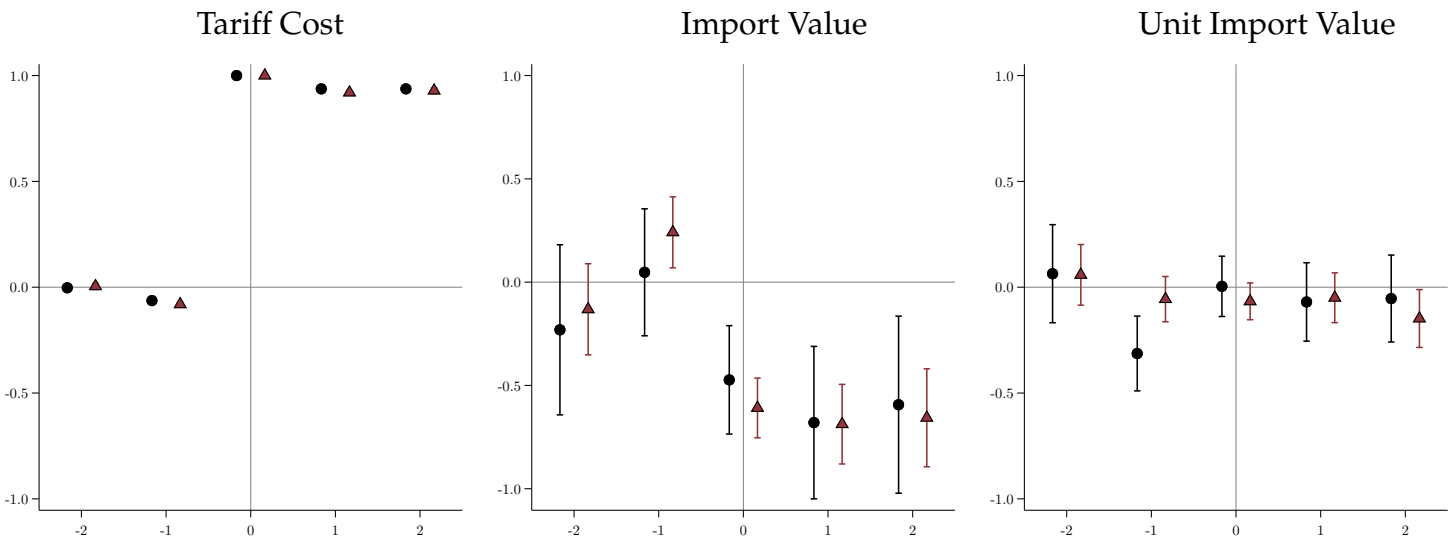
C.3.3 Between-Origin Response of Firm-level Imports

Figure C.2: Between-Origin Elasticity of Firm Imports to Tariff Changes – Alternative Fixed Effects



Note: Sample of 19,509,926 origin-good-firm-destination-year observations. Black circles are estimates of θ^h obtained from (9), along with 95% confidence intervals implied by standard errors (two-way) clustered by good-destination and good-origin. Red triangles are estimates controlling for destination-good-year fixed effect, instead of firm-destination-good-year fixed effects. The dependent variable is the log-change in tariff cost in the left panel ($\Delta^h \log(1+\tau_{ogd,t})$), in (tariff-exclusive) import value in the middle panel ($\Delta^h \log v_{ogfd,t}$), and in unit import value in the right panel ($\Delta^h \log p^W_{ogfd,t}$). In all regressions, we weight observations for each firm by its lagged share of imports from origin o of good g in country d.

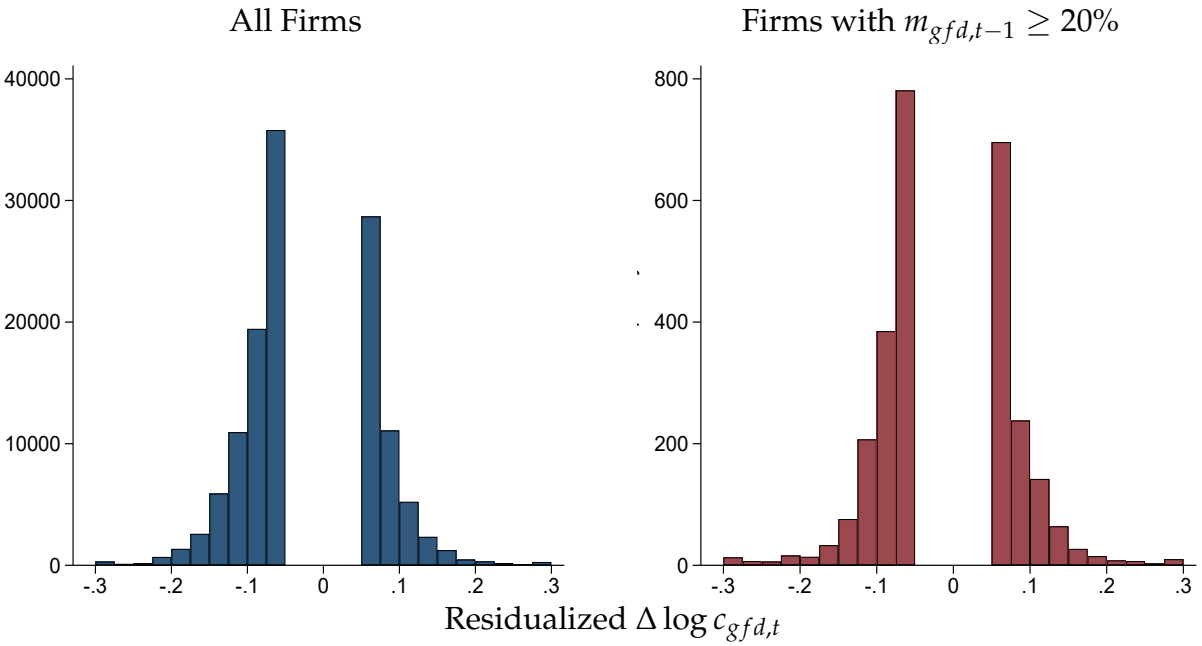
Figure C.3: Between-Origin Elasticity of Firm Imports to Tariff Changes – IV Strategy and Sample Restriction of Boehm et al. (2023)



Note: Sample of 19,509,926 origin-good-firm-destination-year observations. Black circles are estimates of θ^h obtained from (9), along with 95% confidence intervals implied by standard errors (two-way) clustered by good-destination and good-origin. Red triangles are estimates obtained with the strategy proposed by Boehm et al. (2023), which leverages MFN tariff changes in the subsample of small origins of a good subject to MFN tariffs. The dependent variable is the log-change in tariff cost in the left panel ($\Delta^h \log(1+\tau_{ogd,t})$), in (tariff-exclusive) import value in the middle panel ($\Delta^h \log v_{ogfd,t}$), and in unit import value in the right panel ($\Delta^h \log p^W_{ogfd,t}$). In all regressions, we weight observations for each firm by its lagged share of imports from origin o of good g in country d.

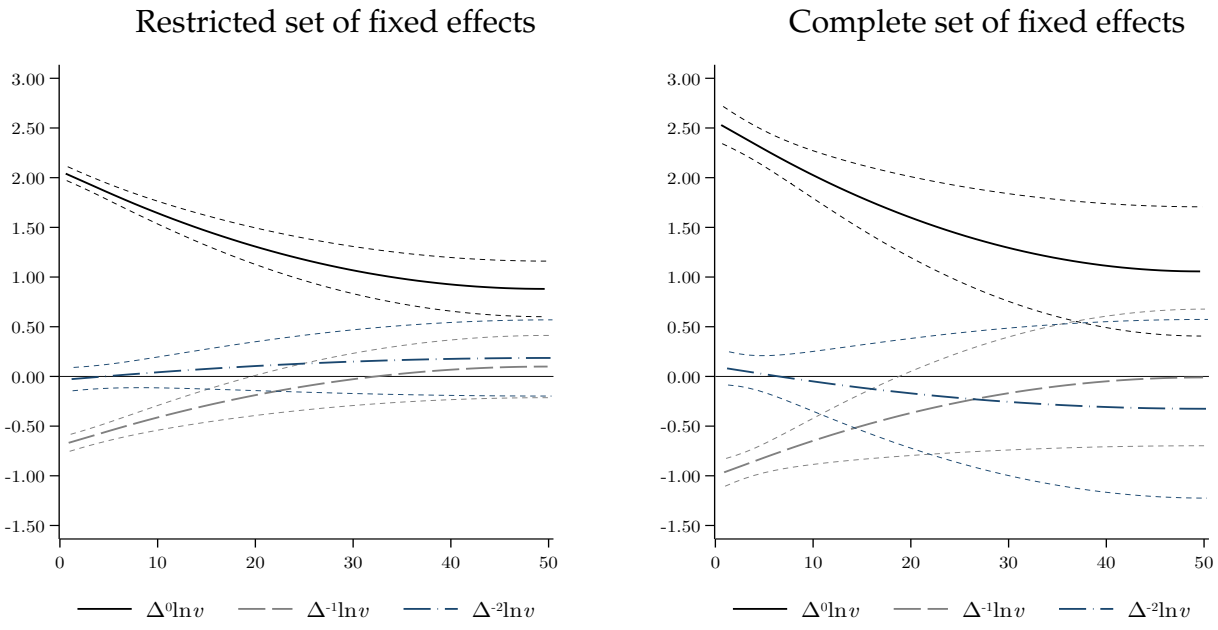
C.3.4 Response of Firm-level Imports

Figure C.4: Frequency Distribution of Changes in Average Tariff Costs, $\Delta \log \bar{\tau}_{gfd,t}$



Note: Figure shows the frequency distribution of $\Delta \log \bar{\tau}_{gfd,t}$ residualized from good-destination-year fixed effects among firm-good-destination-year observations whose value of the residualized $\Delta \log \bar{\tau}_{gfd,t}$ is greater than 5% or smaller than -5%. The left panel shows the frequency distribution for the 127,156 observations in our sample that satisfy this restriction. The right panel shows an analogous frequency distribution but restricted to the subset of 2,748 observations whose share of the destination's imports of the good, $m_{gfd,t-1}$, exceeds 20%. Bin at 0.3 is $\geq .3$; bin at $-.3$ is $\leq -.3$

Figure C.5: Firm's Elasticity of Imports to Tariff Changes



Note: Sample of 13,623,037 firm-good-destination-year observations. Solid lines are estimates of $\beta^q(m)$ for different horizons under a restricted set of good-destination-year fixed effects (excluding $\zeta_{gfd,t}$) in the left panel and the complete set of fixed effects in the right panel, along with dashed lines illustrating 95% confidence intervals implied by standard errors (two-way) clustered by firm-good-destination and good-destination-year. Each solid line corresponds to estimates where the dependent variable is defined over a different horizons with $\Delta^h \ln v_{gfd,t} \equiv \ln v_{gfd,t+h} - \ln v_{gfd,t+h-1}$.

C.4 Between-Good Elasticity of Imports to Tariff Changes

Table C.4: Estimates of Elasticity of Substitution Across HS6 Goods

	(1)	(2)	(3)
	1.855	2.052	-2.119
	(0.379)	(0.349)	(0.371)
R^2	0.038	0.061	0.092
Fixed Effects:			
Country-Year	Yes	No	No
Country-Year-HS2	No	Yes	No
Country-Year-HS4	No	No	Yes

Note: Table reports estimates of elasticity of substitution across HS6 products, η, from equations (11) with country-year fixed effects (column 1) and (11) with fixed effects for country-year-HS2 (column 2) and country-year-HS4 (column 3) from sample of 787,750 good-destination-year observations. Standard errors in parenthesis clustered by good-destination.